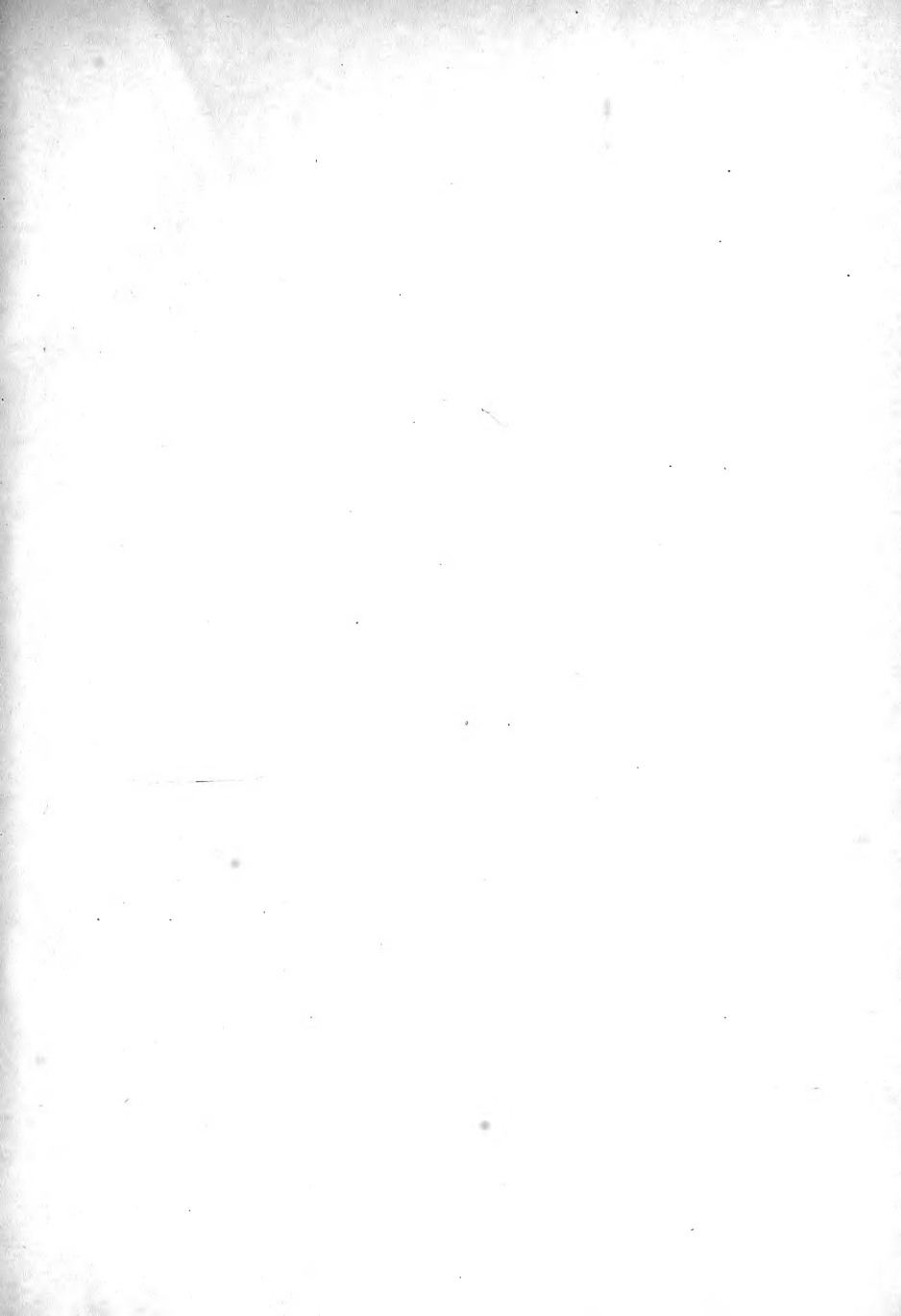
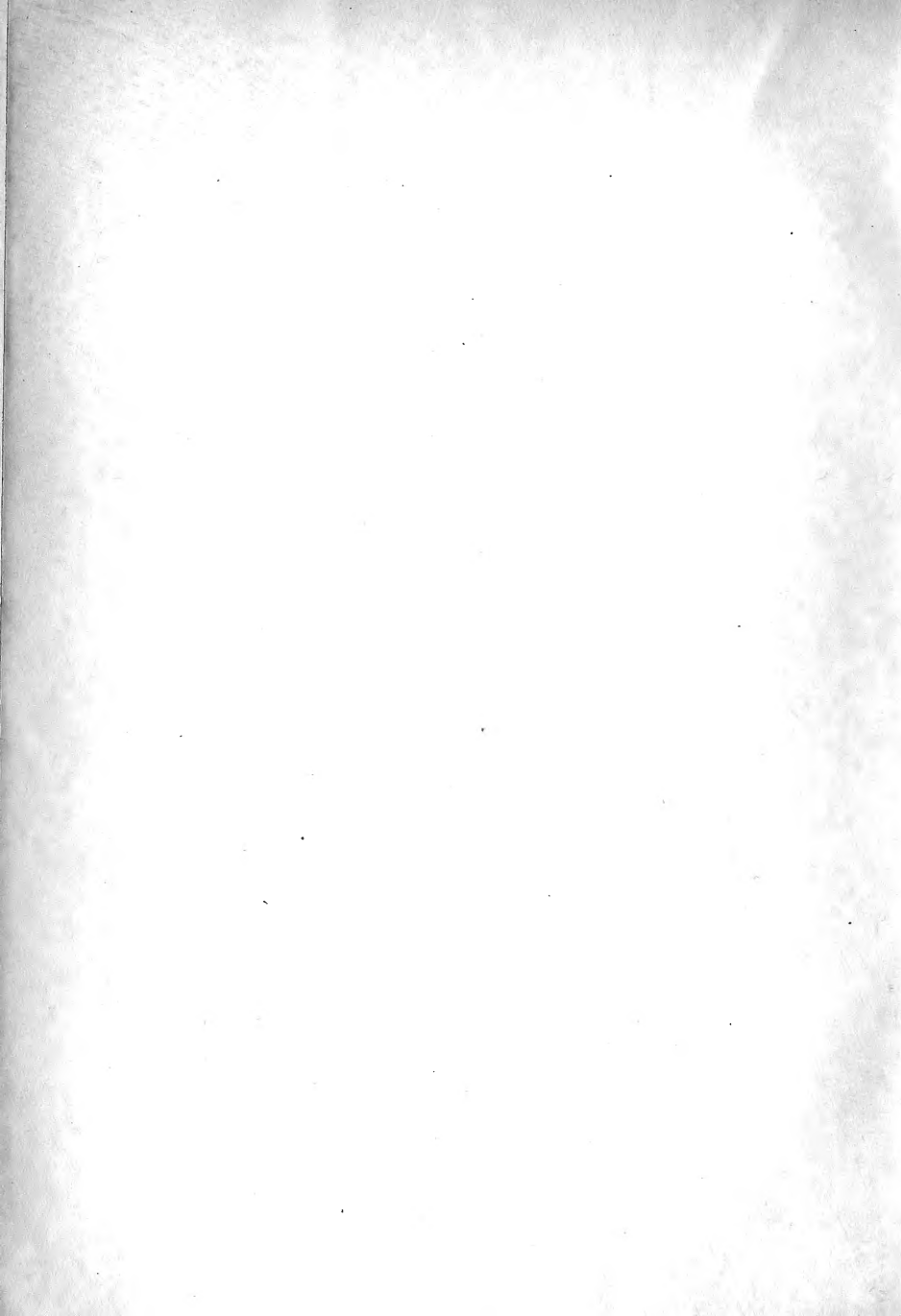
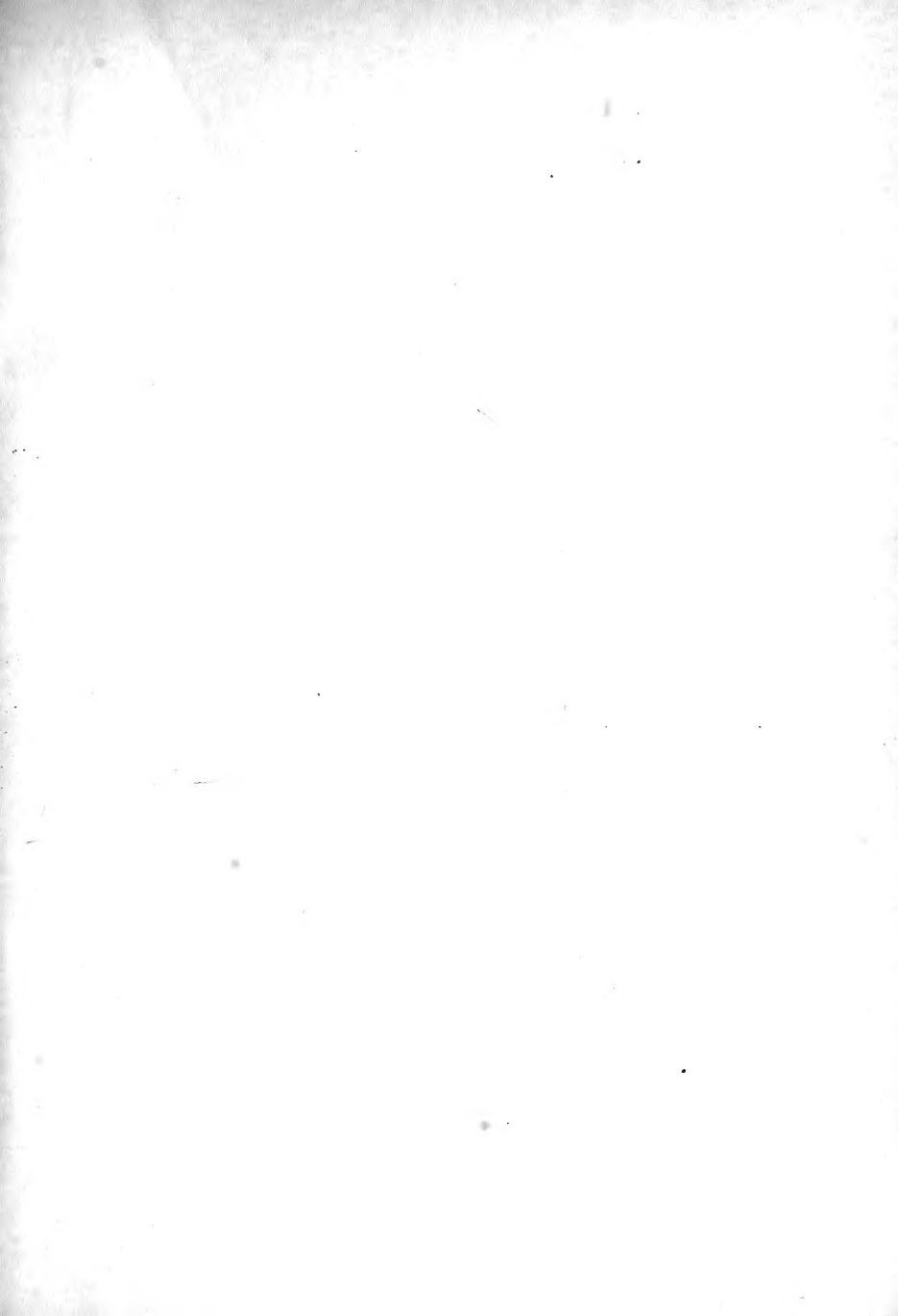
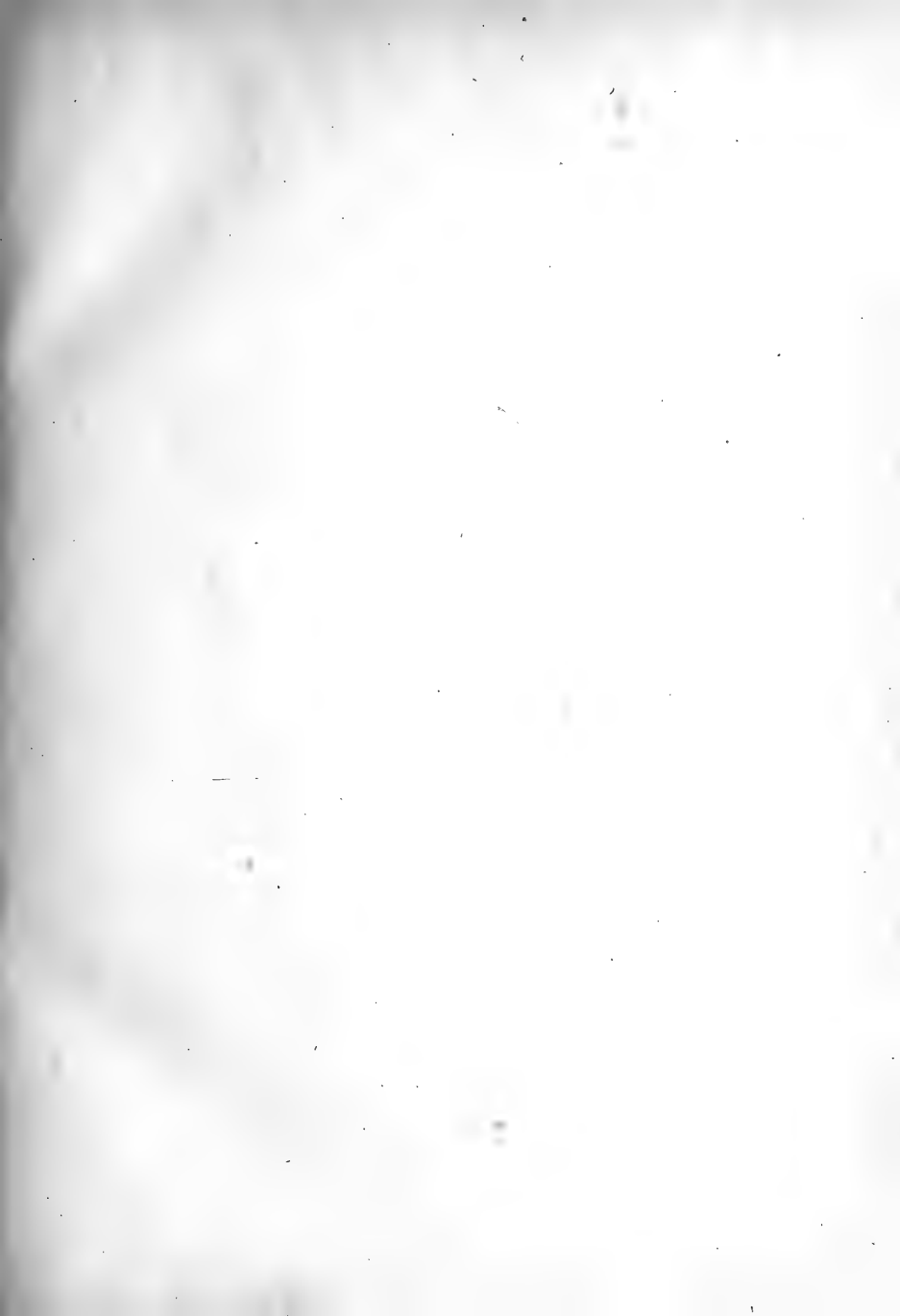


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FRIDAY, JANUARY 5, 1912

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE THE WASHINGTON MEETING

THE sixty-third meeting of the American Association for the Advancement of Science was held at Washington, D. C., December 27 to December 30, 1911, under the presidency of Dr. Charles E. Bessey, of the University of Nebraska. The meeting was the most successful in the history of the association, both from the point of attendance and from the enthusiasm shown. Beautiful weather prevailed throughout and the people of Washington, including the many scientific men connected with the various governmental bureaus, did everything in their power to make the stay of the visitors pleasant and profitable. The total registration of members of the association was 1,306, whereas the largest previous registration was that at the third Boston meeting, when the total was 1,140. A conservative estimate of the actual number of members of the association present in Washington would place the number at 1,800 and there were doubtless as many as a thousand more present who are members of affiliated societies and not members of the association itself. The following is a list of affiliated and other scientific societies which met in Washington at the same time.

Astronomical and Astrophysical Society of America.
American Physical Society.
American Society of Biological Chemists.
American Chemical Society.
Association of American Geographers.

Geological Society of America.
Paleontological Society of America.
American Association of Economic Entomologists.
Entomological Society of America.
American Breeders' Association.

American Psychological Association.
 Southern Society for Philosophy and Psychology.
 Botanical Society of America.
 American Fern Society.
 Society for Horticultural Science.
 American Microscopical Society.
 American Nature-Study Society.
 American Phytopathological Society.
 Sullivant Moss Society.
 American Anthropological Association.
 American Folk-Lore Society.
 American Civic Alliance.
 American Economic Association.
 American Association for Labor Legislation.
 American Sociological Society.
 American Statistical Association.
 American Home Economic Association.
 American Physiological Association.
 Society of American Bacteriologists.
 American Federation of Teachers of the Mathematical and Natural Sciences.
 Signa Xi.

The opening reception to members of the association and affiliated and visiting societies was given at the new National Museum from 8 to 9 P. M. of December 27. At the close of the reception, the association held its first general meeting in the assembly hall of the new National Museum. The meeting was called to order by the retiring president, Dr. A. A. Michelson, who introduced the president-elect, Dr. Charles E. Bessey, who in turn introduced the President of the United States, William H. Taft, who delivered the following address of welcome:

I had a Christmas present a day or two ago. It was a new Encyclopedia Britannica. On the first page of it—I suppose that was the reason why I got it—there was a dedication to King George V. and William Howard Taft, president of the United States. Standing as I do in the presence of this live encyclopedia of all knowledge, I have the same feeling of awe now that I had when I saw that name before all the knowledge of the world. At first I thought somebody else ought to speak before me, but I am glad to come first, because as a welcomer it is not necessary for me to advance a single scientific proposition. I am here only as the Mayor of Washington to advise you that you have the freedom of the

city and that it is a beautiful city which you can not stay too long in. Indeed the longer you stay, the longer you want to stay.

We have centers of science here. We have the Carnegie Foundation for Scientific Research, and one of these days I am going to read the things that come from that research, when I have plenty of time. Then, we have a number of bureaus that I presume would be called bureaus of applied science. I don't refer to the science of government—that is altogether too inexact a science for an assembly like this—but I mean there are certain bureaus connected with this government that I hope present matters of interest to so learned and scientific a body as this. There are some of them that I would like to get my hands on and change, but there are limitations upon the power of the president of the United States and he can not do everything he would like. If I could change the Naval Observatory into a bureau, with a scientific professor at the head of it, I would do it to-morrow, but there are conservative gentlemen connected with the coordinate branches of the government that prevent.

Then, we have the Geological Survey and the Bureau of Chemistry and the Bureau of Entomology and the Bureau of Standards. I have no doubt there is a much longer list, which if I had only committed it to memory, I would give here for your studious consideration. But it is enough of a congeries of scientific nerves to justify a meeting of all the scientific bodies of the country here, and I hope that as the government goes on and as congress becomes more liberal, those centers of scientific research, as many of them ought to be, will be improved so as to commend them to those of you who have theories as to what they ought to be under the auspices and with the necessary money which the United States can devote, if it will, to useful scientific research.

There is only one other remark which I wish to make to-night. In thinking over what there was between this audience and me, of any possible common knowledge, it occurred to me it was some experience in the exercise of the judicial faculty—that is in your lives and in your branches of study and action, the search for truth without regard to the result you reach. That is what makes the administration of justice, what makes the work upon the bench so delightful—the absolute indifference to a result, with the weighing of the reasons pro and con and the final solution in accordance with eternal justice. The scientific man in his search for the truth of nature, in

which he could wrest a rule from nature—a law—and in which he studies each individual instance to find that law, or, if he thinks he has found it, to make the instance square with the law, exercises the judicial faculty in a different branch, but with the same necessity for absolute adherence to truth in order that a useful result may be reached—no forcing of a theory, no construction of individual instances in order to make a theory, if those instances really don't fit into it; and if I know the weakness of the scientist or the temptation of a scientist, it is in reference to just such cases as that. Just as the judge upon the bench, with a weakness for deciding a case in advance, because he has heard one or two things in it, and then tries to square everything else that comes along to his original theory, so, too, with you. I have no doubt that what you have to struggle against is too quick recognition of something that leads you to discover a law. Subsequent study changes your mind about it and then you have to go back and build up a new theory or law, slowly, deliberately, but with strict adherence to truth and a desire to find the truth until you finally conquer and reach a conclusion that will bear the test of every instance.

Dr. Walcott, Secretary of the Smithsonian Institution, who was to have given the second address of welcome, was absent through illness.

President Bessey responded to the address of welcome, as follows:

Mr. President:

The members of the American Association for the Advancement of Science feel it to be a great honor to be welcomed to the capital of the country by its foremost citizen, the president of the United States.

In theory at least scientific men are like the men who frequent this city. They are here for a particular purpose. They work for the good of the community. They are not working for their own advancement. They are servants of the people. In all these things we are like the men who occupy legislative, judicial or executive positions in this capital city.

But, Mr. President, you will permit me to suggest, without unseemly egotism, that in the coming of this body of scientific men to the capital, we represent more than an invasion of an equal number of congressmen, judges and executive officers. If I may be allowed to say it, the latter represent

present problems and needs, and deal only with the things of immediate importance. They are time servers often, or may be mostly in the better sense, but still servers of the present time. And no one will question the usefulness of the man who honestly and conscientiously serves his day and generation—his time.

To the man of science the past, the present, the future, are spread out as the great panorama of nature on which are sketched the successive pictures of an eternity of change and evolution, whose beginning we do not know, and of whose end we have no conception. The politician works wholly in the present and for the present: the scientist's work carries him back through eons of duration to the dawn of eternity, and forward through countless millenniums to a possible twilight time of the universe.

I am not saying that all scientists live in the eternities in this high fashion, nor am I denying that there are great minded statesmen who live in a present which is illumined by the past, and beckoned by the future. No, I would not dare to claim so much for all who enroll in the ranks of science, and certainly we know of some men in public life whose breadth of view on the political questions of the day entitles them to the distinguished name of statesmen.

So I stand here representing a body of men, in some respects like those who are visibly engaged in conducting the government of the country, but in other respects constituting a very different body, and it is on their behalf that I thank you sincerely for the cordial welcome you have extended to us.

But while I speak I am reminded that in these later years you have taken into the service of the government many hundreds of trained scientific men, and that these men by their labors are helping you to solve some of the most difficult problems that the government has had to face. With these men we who assemble here to-day have close ties and cordial sympathies. We remember that although in government service they are still scientific men, and that the problems you have placed before them are scientific problems. And we are anxious, Mr. President, that these brothers of ours shall have full opportunity for doing well the work put before them. We are glad that by the establishment of an enlightened system of laws controlling the civil service this body of scientists has been lifted out of the reach of petty personal politics. That has made it possible for

the government to secure the services of so many men of the highest scientific attainments. It now remains for you, Mr. President, as the executive head over all the scientific bureaus to see that the proper atmosphere is maintained in every bureau, and in every division where scientific men work. It has been hinted sometimes that with all that has been done so well to keep the outside politician away from the scientist's laboratory, we have not wholly succeeded in keeping the inside politician from creating an atmosphere quite inimical to scientific work. For it must be remembered that scientific work is not all a digging out of facts as is so often supposed, but that the best of it calls for comparison, and reflection, and the careful drawing of conclusions, and this takes much time, and mental leisure, and a freedom from petty irritations.

If the men who have to solve the scientific problems of the government are to discharge their duties with the highest efficiency, they must have good appliances in the way of laboratories, experimental stations, apparatus, reference libraries and such other material necessities as pertain to the particular work they have in hand, but more than these, far more I may say, is the necessity for a congenial and sympathetic environment. And rumor has it that this helpful environment is not always present in the splendidly equipped divisions, where it may be that the expert scientist is hampered and distracted by the necessity of making preliminary plans, and preliminary projects, and final plans and final projects, and reports of progress, and preliminary reports, and final reports, and supplementary reports, to officials who neither understand the nature of the problems nor the scientific methods of their study.

We shall agree that these things ought not to be, and I am assured by the interest you have shown in the scientific work of the country at large, and especially by what you have done here in the capital that you will gladly help to free the government scientists from such trammels as may have sometimes hedged them in. In these days when we are applying "scientific management" to business and the industries certainly we ought to have a scientific management of our bureaus of science.

Mr. President, I regard it as a great honor to have had the privilege of responding to the welcome extended to this Association, and doubly so when that welcome has been given by you, whom we all delight to honor, as the president of this good country of ours.

The annual address was then delivered by the retiring president Dr. A. A. Michelson, on "Recent Progress in Spectroscopic Methods," after which the meeting was adjourned.

The addresses by retiring vice-presidents of sections were made as follows:

WEDNESDAY AFTERNOON

Vice-president Frankforter before the Section of Chemistry. Title: The Resins and their Chemical Relations to the Terpenes.

Vice-president Harper before the Section of Botany. Title: Some Current Conceptions of the Germ Plasm.

THURSDAY AFTERNOON

Vice-president Rosa before the Section of Physics. Title: Work of the Electrical Division of the Bureau of Standards.

Vice-president Rotch before the Section of Mechanical Science and Engineering. Title: Aerial Engineering.

Vice-president Hill before the Section of Education. Title: The Teaching of General Courses in Science.

FRIDAY MORNING

Vice-president Moore before the Section of Mathematics and Astronomy. Title: On the Foundation of the Theory of Linear Integral Equations.

FRIDAY AFTERNOON

Vice-president Dixon before the Section of Anthropology and Psychology. Title: The Independence of the Culture of the American Indian.

Vice-president Novy before the Section of Physiology and Experimental Medicine. Title: Carriers of Disease.

Vice-president Burton before the Section of Social and Economic Science. Title: The Cause of High Prices.

Among other addresses which were given and meetings for general discussion which were held, the following may be mentioned:

On Thursday morning, there was a symposium on "The Ether" before the American Physical Society, which was led by Professor A. A. Michelson, who was followed by Professor A. G. Webster and others.

Dr. H. B. Talbot, chairman of the Division of Physical and Inorganic Chemistry, delivered an address on Wednesday afternoon, on the "Privileges and Responsibilities of the Chemical Analyst."

On Thursday evening, the president of the American Chemical Society, Dr. Alexander Smith, addressed the society on the subject, "An Early Physical Chemist." The address was followed by a lecture by Frank B. Kenrick and H. E. Howe, on "Lantern Experiments on Reactions in Heterogeneous Systems."

A symposium on "Drug Assay" was held on Friday morning by the Division of Pharmaceutical Chemistry, and one on "Mineral Wastes and Conservations" was held by the Division of Industrial Chemists and Chemical Engineers.

President R. S. Tarr, of the Association of American Geographers, gave his presidential address on Friday morning, on "The Glaciers and Glaciation of Alaska."

The Paleontological Society of America held a symposium Friday morning, on "Ten Years Progress in Vertebrate Paleontology."

A symposium on "Instinct and Intelligence" was held on Wednesday morning by the American Psychological Association.

The subject of the address of President Franz of the Southern Society for Philosophy and Psychology, given on Thursday afternoon, was "New Phrenology" and that of President Seashore, of the American Psychological Association, given on Thursday evening, was "The Measure of a Singer."

Professor J. H. Comstock addressed the Entomological Society of America on Wednesday evening on "Some Biological Features of Spiders."

The Section of Botany held a symposium on "Soils" on Wednesday afternoon, and the Botanical Society of America held a symposium on Thursday afternoon on

"Modern Aspects of Paleobotany" after the retiring president, Dr. E. F. Smith, had delivered his presidential address on "Some Aspects of the Relationship of the Crowngall Disease to Human Cancer."

Dr. H. M. Beldon gave his presidential address, on "Folk Poetry in America," on Thursday morning, before a joint session of Section H and the American Folk-Lore Society. In the afternoon, the joint session was in charge of the American Anthropological Association and a symposium was held on "Environment and Culture."

Presidential addresses by Dr. F. H. Giddings, president of the American Sociological Society, on the "Quality of Civilization" and by Dr. H. W. Farnum, president of the American Economic Association, on "The Economic Utilization of History," were given before a joint meeting of the two societies, on Wednesday evening.

On Friday afternoon at a joint meeting of Section K with the American Physiological Society and the Society of American Bacteriologists a symposium was held on "Acapina and Shock."

The council of the American Association met daily and the following are the chief items of business transacted:

Eighty-seven new members were elected into the association, and the following were elected fellows of the association: Frank H. Bailey, Fred Asa Barnes, John Fritz, A. A. Hammerslog, Truman Michelson, F. Paul Anderson, Gardner Chace Anthony, Henry Sturgis Drinker, Louis Doremus Huntoon, William Christian Hood, Clement Ross Jones, John Price Jackson, James W. Lawrence, Edwin Hoyt Lockwood, Chas. E. Suche, Francis C. Shenehon, Frederick W. Sperr, James T. Beard, Wm. J. Sharwood, Lula Pace, Pliny E. Goddard, George Byron Gordon, Guy M. Whipple, Milo B. Hillegas, Frederick E. Farrington, Harold

A. Wilson, Frank Wenner, F. C. Brown, E. A. Harrington, W. J. Fisher.

The report of the treasurer for 1910 was presented by the permanent secretary and was accepted and ordered placed on file. The financial report of the permanent secretary was presented, accepted and ordered published.

Dr. H. E. Summers was elected secretary *pro tem* of the council.

The following resolutions were adopted:

1. WHEREAS, the will of the late Jane M. Smith, of Pittsburgh, Pa., a former life member of the American Association for the Advancement of Science, contains the following bequest, namely:

"Seventeenth: I give and bequeath to the National Geographic Society of Washington, D. C., the sum of five thousand dollars (\$5,000); to the American Forestry Association of Washington, D. C., the sum of five thousand dollars (\$5,000); and to the American Association for the Advancement of Science of Washington, D. C., the sum of five thousand dollars (\$5,000). I hereby direct that each of said sums be invested and the net income thereof be used for the purpose of creating life members of said three organizations in cases where worthy and competent persons are not able to pay for such memberships."

Be it therefore *Resolved*, That the permanent secretary of the association be and hereby is authorized to accept from the executors of Jane M. Smith, deceased, the legacy of five thousand dollars (\$5,000) bequeathed by her to the American Association for the Advancement of Science as a fund whose income may be used in the payment of life-membership commutations in the association.

Resolved, That this fund be designated as the Jane M. Smith Fund of the American Association for the Advancement of Science.

Resolved, That said sum of five thousand dollars (\$5,000) or any instalments thereof as they may be received, be turned over to the treasurer of the association for investment in such manner as the council of the association may direct.

Resolved, That the application of the income of the Jane M. Smith Fund in conformity with the wishes of the testatrix be determined by the council of the association after reference to and recommendations from the committee on policy.

2. WHEREAS, more than fifty per cent. of the

injurious insects and plant diseases of first-class importance in the United States have been imported accidentally or in the course of commerce from other countries; and

WHEREAS, the United States of America is the only country among the great nations of the world which has no national quarantine or inspection service looking towards the prevention of such introductions:

Therefore be it *Resolved*, That in the opinion of the American Association for the Advancement of Science the passage of a national quarantine and inspection law directed against the introduction and establishment of injurious insects and plant diseases from other parts of the world is a great desideratum at the present time.

The permanent secretary was directed to transmit copies of this resolution to the president of the United States, the president of the senate, the speaker of the house and the chairman of the committee on agriculture of the house of representatives.

3. *Resolved*, That the permanent secretary be instructed to present for nomination to fellowship the names of those members who are members of affiliated societies, which have already been designated as having qualifications for membership equivalent to fellowship in the association.

4. *Resolved*, That the council of the American Association for the Advancement of Science approves the creation of a Bureau of Astronomy with a scientific chief, which shall have charge of the Naval Observatory and of the Nautical Almanac, and respectfully requests that every endeavor be made to put into operation this plan in the interests of astronomy in the United States.

The permanent secretary is requested to forward a copy of this resolution to the president of the United States, to the president of the senate and to the speaker of the house of representatives.

5. *Resolved*, That Section I be given permission to meet at times and places different from those of the general association, whenever the sectional committee and the committee on policy so agree.

6. *Resolved*, That the treasurer of the association be authorized to invest \$20,000 of the permanent funds of the association in such interest-bearing securities as the committee on policy of the association may approve.

The council instructed the permanent secretary to publish in February or March next a list of officers and members of the

association. The resignations of N. L. Britton and W. H. Welch from the Committee on Policy were accepted and D. T. MacDougal and W. J. Humphreys were appointed to fill the vacancies.

The council authorized an increase in compensation of the present assistant to the permanent secretary from \$100 per month to \$125 per month.

A resolution was adopted recommending that future delegates from the association to international conferences and other delegate bodies be requested to submit brief reports to the council.

A report from Dr. Hutton Webster, delegate to the First Races Contest, was read and ordered filed, and the report of Dr. B. Shimek, delegate to the Third National Conservation Congress, was presented and placed on file.

The council resolved that the American Association for the Advancement of Science reaffirms its approval of the establishment of a National Department of Public Health.

Senator Theodore E. Burton, Dr. Wm. Trelease and Dr. Henry B. Ward were elected to fill vacancies in the council.

The following grants were allowed for the ensuing year:

To the Concilium Bibliographicum \$200
To Mr. Frank C. Gates, A.B., for an investigation of the relation of transpiration to plant structure in bog plants, in collaboration with Professor T. C. Newcombe \$100

The following amendments to the constitution were read as a formal notification in order that they may be acted upon next year under the provisions of the constitution:

Article 31. Substitute for existing article the following:

"The permanent secretary shall publish from time to time a list of officers and members of the association together with such other matter as the council may direct.

Article 3. In closing line omit the word "annual."

Article 6. Omit final sentence.

Article 19. Omit "in the annual volume of Proceedings."

Same article, omit "to the printing and distribution of the annual volume of Proceedings and all other."

Article 22. After "Education" add

"M, Agriculture," or

"M, Agriculture and Forestry," or

"M, Forestry,"

and

"And the council shall have power to create additional sections from time to time when deemed desirable."

Article 22. Lines 4 and 5, change from "H, Anthropology and Psychology" to "H, Anthropology."

Article 22. Abolish Section I.

At a meeting of the general committee held Friday evening, December 29, it was resolved to hold the next meeting at Cleveland, Ohio, the meeting to begin on the Monday of the week in which January first, 1913, falls. It was further resolved to recommend to the next general committee that the meeting for 1913 be held in Atlanta, Georgia. It was further resolved that the committee looks with favor on the plan of holding a summer meeting on the Pacific coast in 1915.

The following officers were elected for the coming year:

President—Dr. Edward C. Pickering, director of the Harvard Astronomical Observatory.

Vice-presidents:

Sec. A—E. B. Van Vleck, University of Wisconsin.

Sec. B—Arthur Gordon Webster, Clark University.

Sec. C—W. Lash Miller, Toronto.

Sec. D—J. A. Holmes, Washington, D. C.

Sec. E—James E. Todd, University of Kansas.

Sec. F—William A. Locy, Northwestern University.

Sec. G—D. S. Johnson, Johns Hopkins University.

Sec. H—J. Walter Fewkes, Washington, D. C.

Sec. I—John Hays Hammond, New York.

Sec. K—J. J. McCleod, Cleveland, Ohio.

Sec. L—J. McKeen Cattell, Columbia University.

Secretaries of Sections:

Sec. B—W. J. Humphreys, Mount Weather, Va.

Sec. E—Geo. F. Kay, University of Iowa.

Sec. K—Waldemar Koch, Chicago University.

General Secretary—H. E. Summers, Iowa State College.

Secretary of the Council—H. W. Springsteen, Western Reserve University.

JOHN ZELENY,
General Secretary

THE WORK OF THE ELECTRICAL DIVISION
OF THE BUREAU OF STANDARDS¹

I. INTRODUCTION

THE Bureau of Standards has grown considerably, both in equipment and personnel, since its inception in 1901. The original staff of fourteen has increased to nearly three hundred, and the material equipment has been augmented in a similar ratio. Its functions also have developed, although authority for all its manifold activities is contained in the brief act of Congress of March 3, 1901, which established the Bureau, and its growth has been closely along the lines laid down by the director in his first announcements of the policy of the new bureau.

The name Bureau of Standards does not signify to the average person the wide scope of the work of the bureau, which is really a national physical, chemical and engineering laboratory. In Germany there are three similar national institutions, and the establishment of a fourth has been proposed; these four combined would cover the field occupied in this country by the Bureau of Standards. The German institutions referred to are the *Physikalisch-Technische Reichsanstalt*, for physics; the *Normal Eichungs-Kommis-*

sion, for weights and measures, and the *Material Prüfungs Amt*, for engineering and the testing of materials. In addition to these three institutions, which have been in active operation for many years, a royal chemical institute for chemistry has been for some time under consideration. In England the National Physical Laboratory occupies a field more nearly like that of the Bureau of Standards, but the Board of Trade divides with it some of these functions.

The work of the Bureau of Standards is distributed among seven divisions, as follows:

- I. Electricity and photometry.
- II. Weights and measures.
- III. Heat and thermometry.
- IV. Optics.
- V. Chemistry.
- VI. and VII. Engineering and the testing of materials.

Thus, it will be seen that the work of Divisions I., III. and IV. correspond to that of the *Reichsanstalt* of Germany, and the remaining four divisions to the other three German institutions mentioned above.

The work of the bureau may be broadly divided into two parts, research and testing, although much time is devoted to the preparation of specifications, the standardization of practise and the diffusion of information that does not fall under either of these heads. To undertake to describe the work of research, testing and standardization carried on in all the divisions of the bureau would be a task requiring more time than is at present available. I shall, therefore, limit myself to the work of Division I., and if I succeed in bringing to your minds a full appreciation of the character and importance of the work we are trying to do in electricity, magnetism and photometry, you may take this when

¹ Address of the vice-president and chairman of Section B, Washington, 1911.

multiplied by six as standing for the work of the bureau as a whole.

2. SCIENTIFIC INVESTIGATIONS

The scientific researches which have been carried out in the electrical division, the results of which are contained in more than 100 papers published in the *Bulletin* of the bureau, may be grouped under the following five heads.

(a) *Theory of Electrical Measurements and of Absolute Instruments.*—One of the first things that demanded attention when the bureau was established was the fixing and maintaining of the standards for electrical measurements, and the choice and development of methods of measurement. This has involved a thorough study of the theory of electrical measurements, and of the theory of the absolute instruments which are employed in the various kinds of absolute electrical measurements. Such studies naturally led to new methods and to the improvement of existing methods, and to a better knowledge of the theory of electrical measurements and of electrical instruments. The *Bulletin* contains twenty-seven papers under this head, including such subjects as the calculation of self and mutual inductance of the various kinds of coils used in the absolute instruments employed in the measurement of resistance and current in C.G.S. units, and in many other kinds of measuring instruments; the theory of different kinds of electro-dynamometers, and of a new method for the absolute measurement of resistance; theory of coupled circuits and other problems in wireless telegraphy, and the preparation of a complete list of formulæ for use in calculating inductances of almost every kind of electric circuit.

(b) *Methods of Electrical Measurement.*—In the work of electrical testing

and research much attention was given to improving methods of measurement, and the *Bulletin* contains thirty-three papers on this subject, including the absolute measurement of inductance and of capacity, the measurement of inductance in terms of capacity by means of alternating currents, wattmeter methods of measuring power, the influence of wave form upon electrical instruments and upon hysteresis losses in iron, the measurement of energy losses in dielectrics, and in iron, a standard method of demagnetizing iron in measurements of magnetic induction, methods of testing transformer iron, measurement of the ratio of transformation and of phase relations in current and potential transformers, quantitative measurements in radio-telegraphic circuits and experiments with high frequency circuits and various papers on methods of measurement in photometry.

(c) *Experimental Researches upon Concrete Electrical Standards.*—The results of absolute electrical measurements are preserved by means of concrete electrical standards, and the practical units of electrical measurements as defined and agreed to by international electrical congresses are expressed in terms of concrete electrical standards, and not in terms of the C.G.S. system. The accuracy attainable in absolute measurements and the definiteness of legal values are both limited by the constancy and reproducibility of the concrete standards by means of which they are expressed and preserved. The principal concrete standards are (1) the *mercury column*, the resistance of which defines the international ohm, and the *wire standards* to which values are assigned in terms of the mercury ohms; (2) the *silver voltameter* which defines the international ampere; and (3) the *Weston normal cell*, the concrete standard employed for the measurement of

electromotive forces, and the value of which is fixed in terms of the international ohm and the international ampere. These concrete standards were defined by the Chicago Electrical Congress of 1893. The principal countries of the world did not, however, adopt the Chicago specifications and numerical values unchanged, so that the international uniformity hoped for was not altogether realized. As the precision of electrical measurements increased and there came a demand for greater accuracy in electrical instruments, the old specifications became inadequate, and the differences in numerical values between different countries became more and more annoying. After attention had been drawn at St. Louis in 1904 to the need of a new international conference for the purpose of securing improved specifications for the concrete electrical standards and uniform numerical values for the same, and after a preliminary conference at Charlottenburg in 1905, in which the program for such an international conference was carefully considered, the conference was called by Great Britain, and met in London in October, 1908. Although considerable attention has been given to the subject of absolute electrical measurements and the preparation of the concrete electrical standards in the fifteen years between 1893 and 1908, it was found at the London Conference impossible to formulate complete specifications for the three primary electrical quantities, and impossible to agree upon a satisfactory value for the Weston normal cell, which latter was adopted at London in place of the Clark cell, as the official standard for expressing the value of the international volt. The discussion at the London Conference brought out clearly the inadequacy of a bulky international conference, sitting for a week or ten days once or twice in a generation, as a tribunal for

settling wisely such technical questions as are involved in the specifications of electrical standards and fixing the values of the standard cells so that it would satisfy Ohm's law. It was recognized that this law could not be repealed or ignored, even by an international conference, and the best that could be done, therefore, was to choose a provisional value for the Weston cell (1.0184 volts at 20°) and to leave to an International Committee on Electrical Units and Standards, established by the London Conference for the purpose, the task of carrying on the investigations, completing the specifications, and finding a new and more precise value of the standard cell. This committee consisted of fifteen members and five associate members, representing eleven different countries, and during the three years that have elapsed since the London Conference it has encouraged investigations in the direction indicated, and has partly accomplished its task. While the committee as a whole has acted in the matter, the experimental work has been done chiefly by the national standardizing laboratories of England, France, Germany and the United States, and in this work the Bureau of Standards has been active.

It might appear that three years is ample time in which to settle all the questions necessary to the satisfactory completion of the work left undone by the London Conference, and so it would be if a reproducibility of one one-hundredth of one per cent. in the standards were deemed sufficient. But when we recall the constancy of the standards of length and mass, and the regularity of the earth as a standard timepiece, we can not be content with our concrete standards of resistance and electromotive force so long as uncertainties exist as great as a thousandth of one per cent. As the demands for greater

precision of measurement increase, the national standardizing laboratory must maintain so high a plane of excellence that those best qualified to judge have the fullest confidence in its fundamental standards and in the accuracy of its work. The endeavor to improve these standards is not merely a matter of doing patiently the same thing over and over again. It means a whole train of investigations, through which an intimate knowledge of the behavior of these standards is obtained, disturbing influences removed or taken account of, impurities in the materials eliminated, and measurements made with what a few years ago would have seemed almost impossible accuracy. The by-products of such researches are often of great value, and become useful in many other directions.

To illustrate, let me refer to the silver voltmeter, the concrete standard of electric current. In 1908 it was believed by many that the chemistry of the Rayleigh voltmeter was simple, and that the most recently published work upon it had cleared up a mystery of long standing, relative to the disagreement of the Rayleigh and Richards forms of voltmeters. Further study at the Bureau of Standards showed complexities due to the presence of filter paper which astonished chemists, and three years of continuous work have not answered all the questions which have arisen as to the effect of traces of organic impurity or of traces of acid or alkali, in the salt, or slight variations in the physical condition of the anode, or the volume and concentration of the electrolyte, or the density of the current, or the influence of dissolved gases. In addition to excellent facilities for purifying materials and making chemical determinations, and an unsurpassed equipment for measuring the current and weighing the deposits, the microscope and ultramicroscope have been

brought into service. And although the outstanding discrepancies are only a few thousandths of one per cent., we have not felt justified in closing the work until the voltmeter as a scientific instrument should be as thoroughly understood as possible.

The construction of standard cells has been beset with similar difficulties. The preparation of the materials has been studied with great pains, and hundreds of cells have been set up and carefully studied. To test their portability, they have been carried from country to country and around the world, and even sent through the mails to Europe and elsewhere. To try to determine the source of small differences between different lots of cells, and between different cells of the same lot, one component at a time has been varied, and materials prepared at different times and in different countries have been used side by side. The result has been a considerable improvement in standard cells, so that for most purposes they are satisfactory, but as standards there is still room for improvement.

One reason for desiring more perfect concrete electrical standards is to facilitate absolute measurements. We now know the value of the absolute ampere better than the value of the absolute ohm, but during the next few years the absolute ohm will probably be realized as well as the absolute ampere now is. Our international electrical units are now so well fixed that one can measure electrical power in international watts with great accuracy. With a better knowledge of the absolute ohm, we shall be able also under proper conditions to measure electrical and mechanical power in watts or in absolute units by means of electrical instruments with high precision.

The work at the Bureau of Standards

on the absolute measurement of current, using an improved form of Rayleigh current balance, has been thorough and exhaustive. To obtain a final result reliable to two or three parts in a hundred thousand requires that all possible sources of error as great as a few parts in a million must be examined and taken into account. It would be impossible in this form of current balance to measure directly the dimensions of the coils with the required precision, and hence the constant of the instrument must be determined by electrical means without such direct measurements; and to detect and eliminate unsuspected errors, several sets of fixed coils and several different moving coils were prepared and used interchangeably, giving the equivalent of several balances. This, in fact, did reveal unsuspected sources of error, and although it greatly prolonged the investigation, it gave results far more trustworthy in the end. A similar story could be told of the work at the bureau on mercury ohms, and on the determination of the ratio of the electrical units.

These are some of the researches in connection with electrical standards, which together constitute the third group of investigations in Division I. of the bureau. Some of them are described in papers contained in the *Bulletin*, and some are in press, and some are not yet completed.

(d) *Improvements in Instruments and the Development of New Instruments.*—In addition to new instruments developed and improvements made in existing instruments employed in the absolute measurements mentioned above, many improvements have been made in electrical instruments used for other kinds of electrical measurements.

Some of these improvements have been adopted by American and foreign instrument makers, and some are embodied only

in instruments in our own laboratories. Among these may be mentioned the following:

(1) The Bureau of Standards type of sealed resistance standard, which is used not only for resistances of highest precision in standardizing institutions, but also for precision standards in ordinary use.

(2) The Bureau of Standards chronograph, for measuring and recording with extreme precision the speed of a machine, as, for example, the speed of a dynamo for the purpose of obtaining the frequency of the current generated with highest precision. It is used on the new apparatus for the measurement of absolute resistance at the bureau, and in connection with the absolute measurement of capacity and inductance, and has been adopted by the National Physical Laboratory on the magnificent machine recently erected at Teddington.

(3) The direct reading potentiometers designed for rapid and accurate work in the measurement of current and voltage, which have been of great service in the work of the bureau, and would be more largely used outside if instrument makers had been quicker to appreciate their merits.

(4) The series of electro-dynamometers for the measurement of alternating current and power, which can be calibrated by direct current and used on alternating. Their range is up to 1,000 amperes, and one recently constructed, but not yet fully installed, will have a range of 5,000 amperes. They are essentially instruments for the testing laboratory, and without them the bureau would have been unable to make many of the tests which have been successfully carried out.

(5) Important improvements have been made in instruments for the accurate comparison of resistance standards and the testing of resistance boxes, potentiometers,

etc. In photometry a number of instruments have been developed or improved, including an automatic recording mechanism, a direct reading scale, a universal rotator, an improved integrating photometer, a direct recorder for life test work, an efficiency meter, etc.

Many other examples of the kind may be cited. In every case, instrument makers and the public have the fullest access to all information concerning new instruments or improvements in old instruments.

(e) *Determining the Properties of Materials.*—The fifth class of scientific investigations concerns the measurement of the properties of materials. Most of the work of this kind is included under the head of testing, the materials tested being in most cases samples of larger lots. But in some cases the work is done to find the average properties of a certain kind of material for the purpose of establishing a standard, or of finding how one property depends upon another. Examples of this kind are the investigations on the mean resistivity and temperature coefficient of resistivity of commercial copper wire. Samples were obtained from many sources, both in America and Europe, and values obtained from measurements made by one of the largest manufacturers, whose instruments and standards had been verified by the bureau.

In this way a mean value was obtained for commercial copper which was made the basis of a new wire table, computed by the bureau at the suggestion of the American Institute of Electrical Engineers, and which they at once adopted in place of their own table. These investigations also brought out a new relation between the temperature coefficient of resistivity and the resistivity itself, so that knowing either of these quantities, the other becomes known.

Another important investigation of this kind recently undertaken is on the relation between the magnetic and mechanical properties of iron and steel, with a view of ascertaining whether it is practicable to test materials for mechanical flaws by magnetic methods. Many investigations on the properties of materials employed in electrical work are needed to answer the hundreds of questions constantly arising, and some of these will soon be undertaken in cooperation with one of the committees of the American Society for the Testing of Materials.

3. ENGINEERING INVESTIGATIONS

In addition to work of the character just described under the head of scientific investigation, laboratory and field work have been conducted on several important practical questions, which may be mentioned under the head of engineering investigations.

One of these had to do with the use of electricity in mines, and the work was undertaken for the purpose of formulating a set of rules suitable for enacting into law, or that could be utilized in revising existing laws, concerning the safe use of electricity for light, power and signals in mines. A careful study of coal mines using electricity, and of the regulations of European and other countries concerning the use of electricity in mines, was made, a great many mining engineers, mine inspectors, mine superintendents and manufacturers of mining machinery were consulted, and the results embodied in a publication on the "Standardization of Electrical Practice in Mines."

Another investigation still in progress has to do with the state and municipal control of the manufacture and sale of illuminating gas. The bureau has been making a thorough study of the methods of testing

illuminating gas for chemical purity, and for its heating and illuminating value. This has involved an investigation of the methods of testing gas and of the instruments employed in such tests. That is, of apparatus used or that may be used in testing for hydrogen sulphide, total sulphur, ammonia, etc.; of gas calorimeters and of gas photometers and flame photometric standards. In connection with this the bureau has made a thorough study of the legal requirements in all the cities and states of the country and of the methods of testing and inspection in use, and has tried to formulate the results of these studies in such a way as to be useful in framing municipal ordinances or state laws on this subject. In this investigation a great deal of field work has been done, and some of the ablest and most experienced gas engineers and city and state inspectors and members of public service commissions have cooperated with the bureau. The results of this investigation, which has already been in progress for more than two years, will be published in two bulletins, one on the specifications of different kinds of illuminating gas and the public regulation of its distribution and sale, and the other on the methods of testing of gas and gas meters. In this work, three of the divisions of the bureau have cooperated.

Another investigation of great engineering importance is that of the effects of stray earth currents (due generally to street railways) upon the corrosion of gas and water pipes and of reinforced concrete structures. Experiments show that under certain circumstances such effects are not only real but serious. The bureau is doing a good deal of field work, as well as laboratory work on this subject, in order to learn the conditions under which the damage is greatest, and how best to

remedy the trouble. The first public report of this work was made recently at the annual meeting of the American Gas Institute, and believing the bureau's work to be of great practical value, the institute voted to appoint a committee to cooperate with the bureau, and expressed the hope that the American Street Railway Association would do the same. Closely associated with the electrolytic corrosion due to stray electric currents is the electrolytic self corrosion, which is under some circumstances very serious and which is often wrongly attributed to railway currents. Electrolytic boiler corrosion, and the corrosion of metal lath used in building, are other examples of the same thing. These are also being investigated, and will be the subjects of published reports.

Another subject of great practical importance that remains to be studied is the life hazard in electric practise, and the proper regulations by states and municipalities for the protection of the public. Much attention is given by the Board of Fire Underwriters to the question of fire hazard, and in protecting buildings from the fire risk much has been done incidentally to reduce the risk to life. But too little attention has been given to the protection of the public from high potential power and lighting circuits, and few cities or states have legislated on the subject. A thorough study of this question, made with the fullest cooperation of the electrical power companies and the manufacturers of insulating materials, would yield results of great practical value, and open the way to municipal and state regulation and inspection.

4. THE TESTING OF INSTRUMENTS AND MATERIALS

Instruments and materials are tested by the bureau for the various departments of

the federal government and for the states and state institutions free of charge. For municipalities and corporations and individuals fees are charged, which in most cases scarcely cover the actual cost of the test, but which are high enough to exclude tests of small importance. In some cases the bureau declines to make tests, as, for example, when it is believed that the proposed test would not settle the question at issue, or where the work would be incommensurate with the value of the result, or where the test is simple and could be done as well elsewhere, and, of course, whenever the facilities or experience of the bureau are not sufficient to warrant attempting the work, or where the work already on hand is too great to permit it. But with these cases excluded, there remains a great variety of tests in all divisions of the bureau, which are being done for the government and the public, and many of these tests are of great practical importance. The fees charged are smaller than they would be if the tests were not generally of value to others besides those who pay for them. Most private tests, indeed, are of public advantage. For example, it is of public concern that manufacturers of electrical instruments have their standards tested at the bureau, as this tends to insure greater accuracy in the instruments sold to the public, without adding appreciably to the cost. That electric lighting companies have their test meters and voltmeters standardized and gas companies have their meter provers and photometric or calorimetric standards tested is a matter of public concern, for it improves the service rendered to the public. If manufacturers of electrical machinery have insulating materials tested for resistance and dielectric strength, and sheet iron and castings tested for magnetic quality, and copper tested for conductiv-

ity, their customers get better machines, and the public better service.

Electrical instruments tested by the bureau include standards of resistance and electromotive force, and precision resistance apparatus of all kinds; condensers and inductances of various kinds used in laboratory measurements and in radiotelegraphy, both commercial and experimental; ammeters, voltmeters, wattmeters, watt-hour meters and many other kinds of measuring instruments, for direct or alternating current; instrument transformers for current and voltage, including those for very heavy currents and high voltages; magnetic instruments; photometers, and various kinds of photometric standards, electric and gas, locomotive headlights, including oil, acetylene and electric; signal lamps, street lamps, etc.

Materials tested include copper, aluminum and other wires used as conductors of electricity; manganin, constantin and other alloys for resistance, thermal electromotive force, etc.; iron and steel and other magnetic or slightly magnetic materials for permeability, hysteresis, coercive force, etc.; sheet steels for iron losses due to alternating magnetizations; insulating materials for instruments and electrical construction; electric lamps for candle power, efficiency and life, and for the quality of the light furnished; oils to be used in standard lamps or as illuminant or for signal purposes, etc.

These tests of instruments and materials are sometimes made for the purpose of seeing whether they conform to the specifications under which they are sold, sometimes for the information of the manufacturer of the given instrument or material, sometimes for the information of an intending purchaser, often for the purpose of re-standardizing the instrument for regular service. A great deal of time is required to keep the equipment employed in testing

in good condition, in order that it may give accurate and trustworthy results, and to check measurements previously made. In most kinds of testing, not half the total cost of the work is due to the time required to make the actual observations and calculations. But that is an inevitable condition, which never can be otherwise. For, if the work is not thoroughly reliable, its value has disappeared.

One of the interesting phases of this testing work is the uniformity which in some cases it maintains throughout the country in the output of different companies and the service rendered by different agencies. Before the bureau began its photometric testing, the standard of candle power varied from ten to twenty per cent. between different companies. The 16 candle-power standard lamps of different manufacturers varied from 14.5 to 17 candles. A 20 candle-power gas lamp on the average gave less light than a 20 candle-power electric lamp, for the unit in the gas industry was based on a different standard and was smaller. Now the unit of candle-power is the same for gas and electric light, and every manufacturer and every lighting company is on the same basis, for all get their standards, directly or indirectly, from the bureau.

Often tests are made to settle disputes, either concerning the accuracy of instruments or concerning the performance of a machine sold under guarantee. The confidence that has frequently been expressed in the justness and impartiality of the bureau's decisions, when thus acting as a court of appeal, has been gratifying to the officers of the bureau.

5. COOPERATION WITH ENGINEERING SOCIETIES

The bureau cooperates with many engineering societies and foreign laboratories

in the work of standardizing and unifying practise, defining terms and improving nomenclature, working out uniform specifications and methods of tests, etc. In this work the division of Electricity, Magnetism and Photometry comes especially into contact with the American Institute of Electrical Engineers, the Illuminating Engineering Society, the Society for the Testing of Materials, the American Committee of the International Electrotechnical Commission and the International Committee on Electrical Units and Standards. The bureau is represented on the council or committees of all of these bodies, and each year many subjects arise that come within the field of the bureau's activities, and in the handling of which its representatives can cooperate. Reference was made above to the new tables of resistance for annealed copper wire. Heretofore, the English, German and American tables have all been different, not only for resistivity, but also for temperature coefficient, and two different densities were in use. Through the efforts of two of the above-mentioned bodies and the Bureau of Standards acting together in the negotiations with foreign laboratories and scientific societies, we are assured in the near future of international uniformity in all these quantities. Much has been accomplished also in securing international uniformity in electrical units, a common photometric unit in England, France and America, in comparing and standardizing measurements of electrical and magnetic quantities between national laboratories, etc.

The preparation of standard specifications for various kinds of materials is an important work, in which the bureau cooperates with the engineering societies and with the departments of the government.

6. COOPERATION WITH THE DEPARTMENTS OF THE GOVERNMENT

In addition to its cooperation with the departments of the government in the direction just noticed, and in doing testing in considerable quantity, the bureau cooperates with the departments also in other ways. With the War and Navy departments it cooperates in experimental work on radio-telegraphy, and several rooms in the bureau's laboratory are occupied by representatives of the signal corps of the army, and of the Navy Department, in this work. The bureau also renders technical assistance to the Bureau of Navigation, of the Department of Commerce and Labor, which is charged with the administration of the law requiring all passenger ships carrying fifty passengers or more to be equipped with radio-telegraphic apparatus. Its traveling inspectors visit the lamp factories and inspect for the various departments of the government a million electric lamps a year, taking samples for life test at the bureau.

7. DISSEMINATION OF INFORMATION

In addition to the scientific and engineering papers published in the *Bulletin*, and in the Bureau's Technologic Series thirty-one circulars of information have been published by the bureau on a variety of subjects, and among these nine have been prepared by the Electrical Division, and several others are in preparation. Among those issued may be mentioned "Standard Specifications for Incandescent Lamps," "A Proposed International Unit of Light," "Magnetic Testing," "Testing of Electrical Measuring Instruments," "Precision Measurements of Resistance and Electromotive Force" and "Transformer Specifications."

A large amount of time is expended in answering letters which request informa-

tion. These come from many classes of inquirers, asking many kinds of questions, some very easy and some very hard to answer. All receive careful attention, no matter how humble the writer or how simple the question. We in our turn write a great many letters asking for information, and we have to acknowledge the uniform courtesy accorded to such inquiries, and the valuable information often so obtained.

Much information is communicated also to those who call personally at the bureau, and this is naturally an increasing quantity. As the apparatus, methods of measurement and results for the most part are open to the public, many find it advantageous to make personal visits. An exception is made as to the results of tests for which a fee is paid, these being held as confidential and communicated only with the consent of the person for whom the test was made.

Enough has been said to show the great variety of the work in one division of the bureau, which may be taken as typical of all. It extends from the purely scientific investigations on the one hand to the most practical of engineering problems on the other. The work in electricity, magnetism and photometry is distributed among three different buildings, and needs more space. The new building now under construction, which will be 190×60 feet in floor area, with four stories and basement, will afford larger and better accommodations for this work.

In closing this necessarily incomplete account of the work of the electrical division of the bureau, let me say a few words as to the reasons for testing instruments and materials purchased by the government. Most people admit the advantage of such testing, but few appreciate how important it is, or how many sided is the question of

testing in connection with government purchases. It is of importance from a business standpoint, and as a matter of good engineering. It is also of great importance as contributing to good government.

8. REASONS FOR TESTING MATERIALS PURCHASED BY THE GOVERNMENT

1. The first and most obvious reason for testing instruments, machinery and materials purchased by the federal government is of course to insure the government getting what it pays for. But that is not the only reason, and in some cases it may not be the main reason. Such testing is done upon many kinds of materials, but for a concrete illustration we may think of electrical instruments or electric lamps.

(1) With the results of a thorough and impartial test at hand, a government engineer, charged with drawing specifications for a given kind of instrument or material, knows what performance can be secured by such instruments, or what properties can be expected in the given material, and hence is able to prepare the specifications intelligently.

(2) With the results at hand of tests on the instruments or materials of different makes, the purchasing officer knows what makers to invite to submit bids for government requirements. If those whose instruments or materials are unsuited for the given purpose are not permitted to bid, expense and trouble are avoided, both to the manufacturer and to the government.

(3) If the results of thorough tests are available, the purchasing officer can take account of the quality as well as the price in making awards of contracts. It often happens that any one of several makes of instruments or materials can be used, and it is necessary to know the differences in quality as well as the differences in price

in order to determine which bid is best. The practise of accepting the lowest bid regardless of quality often causes dissatisfaction both to those who bid for the government's business and those who use the articles purchased.

(4) If tests are systematically made, a conscientious purchasing officer is protected from charges of favoritism or collusion in the performance of his duty. His answer to such intimations, whether they come from dealers or those in authority, is the certified results of tests upon which he had relied. If the tests have been made in an impartial and well-equipped laboratory established for the purpose, the results are likely to be given greater weight, and the protection to the purchasing officer is greater, than if done by the bureau or department making the purchase. Purchasing under such a system of testing, the opportunity and the temptation to collusion between purchasing officer and contractor is greatly reduced. Such collusion is not frequent in the government service, but it has occurred, and it is desirable to reduce the opportunity for it to a minimum.

(5) Purchasing under a system of thorough and systematic tests protects administrative and purchasing officers from political pressure in connection with purchases, and members of congress are spared from the appeals of constituents in connection therewith. It has sometimes happened that a manufacturer or contractor on failing to secure a government contract feels that he has been discriminated against, and in good faith goes to his congressman or senator with his grievance. The latter is placed in an embarrassing position, between his desire to serve his constituent and his uncertainty as to the real facts in the case. A system of fair and thorough testing of materials in connection with public advertising removes almost entirely

any occasion for appealing to a member of the legislative branch of the government concerning business transactions in the executive departments.

(6) If the instruments or materials are delivered from time to time, tests are necessary in order to see that the deliveries are in accordance with the samples or the specifications. If deliveries are accepted without tests or inspection, or with inspection only, the door is opened for deception and fraud; honest dealers or manufacturers are at a disadvantage in competition with unscrupulous ones in dealing with the government; and it may result under such circumstances that the most reliable manufacturers will refrain from bidding on government business, leaving those who are willing to misrepresent their products to compete with one another for the government patronage. The government then becomes a party to fraudulent transactions, and to a greater or less extent tends to demoralize business. On the other hand, if careful inspections and tests are regularly made, and acceptances are conditioned on meeting the specifications, manufacturers often thereby become better acquainted with the properties of their own products, honesty and uprightness in business are encouraged, a standard of quality is set for the given instrument or material which helps other purchasers besides the government, and the whole industry may be greatly benefited.

(7) If the reports of such tests are communicated to the manufacturers, as they generally are, defects in the product are perhaps sooner discovered and sooner remedied, and if the government invites the cooperation of the manufacturers when undertaking tests of types of instruments or of materials, the tests are likely to be fairly conducted and the results representative.

(8) In these days of commercial combinations and gentlemen's agreements as to prices, it sometimes happens that the government can not secure competition in price, but finds that the bids from different manufacturers are identical in price. Here again, testing the product solves an otherwise serious difficulty, for it is generally possible even in this case to secure real competition as to quality, and this is quite as important as competition in price.

It is thus seen that there are many reasons for testing the thousands of kinds of instruments, machines and materials purchased by the government, and for doing this, in large measure at least, in a well-equipped institution set apart for that purpose. The Bureau of Standards has done considerable work of this kind, but the government's purchases are so varied and so vast, and so many requests for tests came from states, municipalities, and the public, that the work involved is very great, and only a fraction of the work is done which could be done with profit. Whether the bureau shall grow in the future as fast as the demands upon it for testing and investigation increase is uncertain. But if it does only a part of the work waiting to be done, and does that part well, it will amply justify its existence, and in so doing save the government and benefit the industries far more than the cost of its maintenance.

EDWARD B. ROSA

BUREAU OF STANDARDS

PROGRESS IN INDUSTRIAL FELLOWSHIPS

IN the issue of *SCIENCE* for Friday, May 7, 1909, I presented the main outlines and contemporary status of a scheme of industrial fellowships initiated by me in an article in the *North American Review* for May, 1907. Since this statement I have made no report to this journal.

I now present the establishment of a new

series of fellowships, not only at the University of Kansas, but at the University of Pittsburgh. The industrial fellowships so far established at the University of Pittsburgh and now in operation are as follows:

1. *Baking*.—\$750 a year for 2 years. Additional cash bonus of \$2,000. Fellow: Wilber A. Hobbs, A.B., University of Kansas, instructor in chemistry.

2, 3. *Abatement of the Smoke Nuisance (Multiple Fellowship)*.—\$12,000 a year for 2 years. Additional consideration, 49 per cent. collective interest. Fellows: Raymond C. Benner (senior fellow), Ph.D. University of Wisconsin, assistant professor University of Arizona; W. W. Strong (second fellow), Ph.D. Johns Hopkins University, Carnegie assistant and assistant in chemistry Johns Hopkins University. Other fellows to be appointed.

5. *On the Relation of the Pots to Glass in Glass-making and the Elimination of "Strea."*—\$1,500 a year for 2 years. Additional cash bonus of \$2,000. Fellow: Samuel Ray Scholes, Ph.D. Yale University, H. B. Loomis fellow in chemistry Yale University.

6, 7, 8. *Baking (wholly Independent of but with Acquiescence of No. 1) (Multiple Fellowship)*.—\$4,750 a year for 2 years. Additional consideration of \$10,000. Fellows: Henry A. Kohman (senior fellow), Ph.D. University of Kansas, holder of National Association of Master Bakers' fellowship; Charles Hoffman (second fellow), B.S. University of Kansas, laboratory assistant Yale University; Alfred Edward Blake (third fellow), B.S. New Hampshire College, assistant in chemistry Rensselaer Polytechnic Institute.

9. *Glue*.—\$1,200 a year for 2 years. Fellow: Ralph C. Shuey, B.S. University of Kansas, former industrial fellow University of Kansas.

10. *Soap*.—\$1,200 a year for 2 years. Fellow: Paul R. Parmelee, B.S. University of Kansas, curator of chemistry and pharmacy department, University of Kansas.

11. *Utilization of Fruit Waste*.—\$1,000 a year for 2 years. Additional consideration, \$10,000. Fellow: F. Alex. McDermott, George Washington University, of Hygienic Laboratory, Washington, D. C.

12, 13, 14, 15, 16. *Crude Petroleum (Multiple)*.—\$10,000 a year for 2 years. Collective interest of 10 per cent. Fellows: Raymond F. Bacon (senior fellow), Ph.D. University of Chicago,

chemist Bureau of Science, Manila, assistant chemist Bureau of Chemistry, Washington, D. C.; Lester A. Pratt (second fellow), M.S. New Hampshire College, instructor at New Hampshire College; C. W. Clark (third fellow), M.A. Ohio State University, assistant chemist Bureau of Chemistry, Washington, D. C.; Hugh Clark (fourth fellow), M.A. Ohio State University; Arthur H. Myer (fifth fellow), A.M. Leland Stanford University, assistant department of chemistry, Stanford; Fred W. Padgett (scholar), University of Kansas.

17. *Composition Flooring*.—\$1,500 a year for 2 years. 1 per cent. of sales for 5 years. Fellow: R. R. Shively, B.S. Oklahoma A. & M. College, assistant chemist Bureau of Chemistry, Washington, D. C.

18, 19. *Natural Gas (Multiple)*.—\$4,000 a year for 2 years. 5 per cent. of industrial results. Fellows: Clarence L. Speyers (senior fellow), Ph.D. Harvard University, Carnegie assistant Harvard University; Roy H. Uhlinger (second fellow), M.A. University of Pittsburgh, fellow in chemistry University of Pittsburgh.

20. *Cement*.—\$1,800 a year for 2 years. \$10,000 additional consideration. Fellow: J. F. MacKey, Ph.D. University of Toronto, former industrial fellow University of Kansas.

The fellowships above listed went into operation September 1 of the current year. They involve the work of twenty fellows and a salary list of \$39,700 a year for two years, or \$79,400 in all. The work is being conducted in a temporary but efficient building erected at a cost of about twelve thousand dollars.

At the University of Kansas, where this work has been in operation since 1907, I have to report the foundation of the following new fellowships, not yet published in SCIENCE:

10. *On the Chemical Treatment of Wood*.—\$1,500 a year for 2 years. Large additional consideration. Fellow: L. V. Redman, Ph.D., University of Toronto.

11. *On New Utilities for Borax*.—\$750 a year for 1 year. Fellow: B. C. Frichtot, B.S., University of Kansas.

12. *On the Chemistry of Vegetable Ivory*.—\$1,500 a year for 2 years. Maximum cash bonus of \$2,000. Fellow: J. P. Trickey, A.B., New Hampshire College, University of Toronto.

13, 14. *On the Relation of Crude Petroleum to the Manufacture of Soap*.—\$2,750 a year for 2

years. Maximum cash bonus of \$5,000. Fellows: F. W. Bushong (senior fellow), Ph.D., former industrial fellow at University of Kansas; J. W. Humphreys (second fellow), A.M. University of Kansas.

15. *On the Chemistry of Gilsonite*.—\$750 a year for 1 year. Maximum cash consideration of \$2,000. Fellow: W. E. Vawter, A. B. University of Kansas.

16, 17, 18. *On the Chemical Treatment of Wood*.—\$3,900 a year. Owing to the remarkable progress of fellowship No. 10 during the first year, the donating company extended its value to \$3,900 a year and thus provided for the aid of two additional fellows. Fellows: L. V. Redman (senior fellow), Ph.D. University of Toronto; Frank P. Brock (second fellow), A.B. University of Kansas; Archie J. Weith (third fellow), A.B. University of Kansas.

Altogether, both at the University of Kansas and at the University of Pittsburgh, there

have been so far involved \$113,400 for direct expenditure in salaries in industrial research.

ROBERT KENNEDY DUNCAN

UNIVERSITY REGISTRATION STATISTICS

THE registration returns for November 1, 1911, of twenty-seven of the leading universities of the country will be found tabulated below. Seven institutions exhibit a decrease in the total enrollment (including the summer session) this year, viz., Chicago, Minnesota, Missouri, Nebraska, Northwestern, Texas and Yale, although in the case of Minnesota and Nebraska the apparent loss is due to a change of classification. The largest gains in terms of student units were registered by California (966), where the summer session showed an increase of 913 students, Columbia (527), Cornell (440) and

	Total Attendance November 1, 1911	Attendance Summer Session, 1911	Grand Total	Deduct Summer Session Stu- dents who Re- turned in Fall	Net Total, November 1, 1911	Total, No- vember 1, 1910	Total, No- vember 1, 1908	Total, Novem- ber 1, 1903
California.....	4051	1964	6015	291	5724	4758	3751	3690
Chicago.....	2666	3248	5914	524	5390	5883	5114	4146
Columbia.....	5669	2973	8642	704	7938	7411	5675	4657
Cornell.....	4889	1152	6041	432	5609	5169	4700	3438
Harvard (incl. Radcliffe).....	4724	787	5511	85	5426	5329	5342	6013
Illinois.....	4570	647	5217	288	4929	4659	4400	3239
Indiana.....	1350	1068	2418	264	2154	2132	2113	1143
Iowa.....	1772	309	2081	114	1967	1957	2356	1260
Johns Hopkins.....	740	335	1075	18	1057	784	698	694
Kansas.....	2019	429	2448	183	2265	2246	2086	1319
Michigan.....	4783	1194	5977	525	5452	5339	5188	3926
Minnesota.....	4307	476	4783	235	4548 ²	4972	4607	3550
Missouri.....	2273	507	2780	184	2596	2678	2558	1540
Nebraska.....	2474	403	2877	144	2733 ³	3661	3154	2513
New York.....	3688	490	4178	123	4055	3947	3951	2177
Northwestern.....	3387	94	3481	43	3438	3543	3113	2740
Ohio State.....	3085	792	3877	310	3567	3181	2700	1710
Pennsylvania.....	4718	682	5400	180	5220	5187	4555	2644
Princeton.....	1543	—	1543	—	1543	1451	1314	1434
Stanford.....	1634	50	1684	36	1648	1648	1541	1370
Syracuse.....	3183	225	3408	101	3307	3248	3204	2207
Texas.....	1935	734	2669	130	2539	2597	1446	785
Tulane.....	1192	936	2128	88	2040	1985	1171	1037
Virginia.....	804	—	804	—	804	688	757	638
Western Reserve.....	1331	—	1331	—	1331	1274	1016	765
Wisconsin.....	3956	1536	5492	477	5015	4745	3876	3221
Yale.....	3224	—	3224	—	3224	3287	3466	2990

¹ In all faculties, excluding preparatory or extension department.

² These figures do not include the registration in the two branch schools of agriculture, nor in any of the short courses, some of which were included

in the previous years. The actual attendance this fall is practically identical with that of 1910.

³ Certain classes of students counted in previous years must have been omitted in the total for 1911, since the institution reports a gain over last year.

Ohio State (386). Last year there were seven institutions that showed a gain of over three hundred students, California and Columbia being among the number. Omitting the summer session attendance, the largest gains have been made by Cornell (307), Ohio (282), Illinois (241), Columbia (223), Michigan (132), New York University (118) and Virginia (116). It will thus be seen that this year only four institutions exhibit an increase of over two hundred students in the fall attendance, as against seven in 1910 and eleven in 1909.

According to the figures for 1910, the twenty-seven universities included in the table ranked as follows: Columbia, Chicago, Michigan, Harvard, Pennsylvania, Cornell, Minnesota, California, Wisconsin, Illinois, New York University, Nebraska, Northwestern, Yale, Syracuse, Ohio State, Missouri, Texas, Kansas, Indiana, Tulane, Iowa, Stanford, Princeton, Western Reserve, Johns Hopkins, Virginia. Comparing this with the order for 1911, and leaving Minnesota and Nebraska out of consideration, we find that Columbia continues to maintain its long lead, that California has passed from the eighth to the second place, that Cornell has passed from the sixth to the third place, that Michigan and Harvard have each dropped down one place, Pennsylvania two places, and Chicago four, and that Wisconsin and Illinois have advanced a place owing to the change in the Minnesota figures. The balance of the institutions now rank in the following order: New York University, Ohio State, Northwestern, Syracuse, Yale, Nebraska, Missouri, Texas, Kansas, Indiana, Tulane, Iowa, Stanford, Princeton, Western Reserve, Johns Hopkins, Virginia. California is the seventh and Wisconsin the eighth institution to pass the five thousand mark. If the summer session enrollment be omitted, the universities in the table rank in size as follows: Columbia, Cornell, Michigan, Harvard, Pennsylvania, Illinois, Minnesota, California, Wisconsin, New York University, Northwestern, Yale, Syracuse, Ohio State, Chicago, Nebraska, Missouri, Kansas, Texas,

Iowa, Stanford, Princeton, Indiana, Western Reserve, Tulane, Virginia and Johns Hopkins, the order of the first ten institutions last year on this basis being Columbia, Minnesota, Michigan, Pennsylvania, Harvard, Cornell, Illinois, California, Wisconsin, New York University.

The detailed statistics by faculties will hereafter be given in the spring, in order that the final figures for the year may be provided instead of the preliminary registration only. The number of students entering in the second term at the larger institutions is growing constantly, and as a result the final enrollment frequently shows a considerable increase over that of November first. The changes in attendance, equipment, etc., will also be submitted at that time.

The fall enrollment at a number of prominent colleges (for men and for women) and schools of technology is given in the following table:

Institution November 1	1911	1910	1904
Amherst.....	464	502	412
Brown (incl. graduate school)....	933	930	988
Bryn Mawr (incl. graduate school).....	440	409	441
Dartmouth (incl. eng., med., grad., stud., and commerce)...	1,385	1,229	926
Haverford.....	164	150	146
Lehigh.....	599	616	609
Massachusetts Institute of Technology.....	1,610	1,506	1,561
Mount Holyoke.....	771	743	674
Purdue.....	1,762	1,611	1,359
Smith.....	1,508	1,618	1,067
Wellesley.....	1,433	1,378	1,050
Wesleyan.....	395	365	305
Williams.....	533	541	443

RUDOLF TOMBO, JR.

COLUMBIA UNIVERSITY

SCIENTIFIC NOTES AND NEWS

PROFESSOR EDWARD C. PICKERING, director of the Harvard College Observatory, has been elected president of the American Association for the Advancement of Science, to preside at the meeting to be held at Cleveland, Ohio, beginning on December 30, 1912.

PROFESSOR E. L. THORNDIKE, of Teachers College, Columbia University, was elected

president of the American Psychological Association at the recent Washington meeting.

COLONEL WM. P. GORGAS has been elected president of the ninth Congress of American Physicians and Surgeons, which meets in Washington in May, 1913.

PROFESSOR H. L. FAIRCHILD, of the University of Rochester, has been elected president of the Geological Society of America.

THE following have been elected foreign members of the Royal Society: Dr. Johann Oscar Backlund, of Pulkowa, imperial astronomer of Russia; Dr. Heinrich Ritter von Groth, professor of mineralogy in the University of Munich; Heinrich Kayser, professor of physics in the University of Bonn; M. Joseph Achille Le Bel, of Paris, the chemist, and Klement A. Timiriazeff, professor of botany in the University of Moscow.

LORD CROMER and the Hon. Lionel Walter Rothschild have been elected fellows of the Royal Society under the statute which empowers the council once in every two years to recommend to the society for election not more than two persons who in their opinion have rendered conspicuous service to the cause of science.

DR. CARLOS FINLAY, of Havana, has been elected a corresponding member of the Paris Academy of Medicine.

It is stated in *Nature* that Professor G. Elliot Smith, F.R.S., professor of anatomy in the University of Manchester, has been awarded by the Paris Anthropological Society the Prix Fauvelle, of one thousand francs, for his researches in the anatomy and physiology of the nervous system.

GOVERNOR DIX has requested the resignation of Dr. Alva H. Doty as health officer of the Port of New York. Two weeks before a largely attended meeting of physicians of the New York Academy of Medicine, presided over by Dr. Abraham Jacobi, had passed resolutions requesting the reappointment of Dr. Doty, and referring to the admirable manner in which he had filled the position for the past sixteen years.

PROFESSOR VON WASSERMANN, the bacteriologist, has been appointed honorary professor at Berlin.

PROFESSOR ZIEMANN has resigned the charge of the public health service in Cameroon, Africa, on account of his health.

E. W. RUST, A.B. (Stanford), formerly at the Southern California Laboratory, has contracted with the Peruvian government for eighteen months as first assistant entomologist. He arrived in Peru early in December.

MR. L. H. WORTHLEY, assistant state forester of Massachusetts, in charge of the moth work, has accepted a position in the Bureau of Entomology. He will proceed to Europe to study the conditions on the continent.

MR. FLOYD B. JENKS, assistant professor of agricultural education in the Massachusetts Agricultural College, has accepted an appointment in the Bureau of Education.

PROFESSOR FINKLENBURG, of Bonn, has assumed the direction of the hydrotherapeutic institute, Berlin, as successor to Professor Strasburger.

Nature states that the presentation of a testimonial to Mr. Henry Keeping on his retirement from the post of curator of the Geological Museum, Cambridge, took place in the Sedgwick Museum on Saturday, December 2, when Professor T. McKenny Hughes handed him a purse subscribed by old friends and students in recognition of his long and valuable services. Mr. Keeping entered upon his duties as curator fifty years ago under Professor Sedgwick in the old Woodwardian Museum, where the geological department was located until its removal into the Sedgwick Museum in 1904.

PROFESSOR W. E. CASTLE, of Harvard University, who has left Cambridge to visit a number of countries of South America, chiefly Peru, wishes to obtain certain rodents for experimental work in genetics at the Bussey Institution. Part of the expenses of Professor Castle's trip are borne by the Carnegie Institution. He expects to return to Cambridge about February 1, although his trip may be prolonged until the first of March.

HIRAM BINGHAM, professor of Latin-American history at Yale University, has returned from a six months' journey of exploration in Peru.

It is stated in *The Condor* that Mr. W. Leon Dawson spent a portion of the field season in out-door work contributory to his projected "Birds of California." The Farallone Islands and the Mount Whitney region were visited.

MR. W. BATESON, F.R.S., director of the John Innes Horticultural Institution at Merton, Surrey, has been appointed the next Herbert Spencer lecturer at Oxford. The subject of the lecture, which will be given on February 28, is "Biological Fact and the Structure of Society."

WE learn from *Nature* that the dean of Westminster, with the full concurrence of the chapter, offered to the family to permit the interment of Sir Joseph Hooker's ashes in the abbey, on the condition that his remains were previously cremated. The family has felt obliged to decline the offer as it was Sir Joseph's express wish that he should be buried by the side of his father at Kew. The funeral took place at Kew Parish Church on December 15.

MR. WILLIAM THYNNE LYNN, formerly assistant in the Royal Observatory, Greenwich, and the author of various contributions to astronomy, especially on its history, died on December 11, aged seventy-six years.

DR. DAVID STARR JORDAN, of Stanford University, one of the vice-presidents of the first international eugenics congress to be held at the University of London from July 24 to 30, 1912, has accepted the presidency of the consultative committee for the United States. The officers of the congress hope that it will result in a far wider recognition of the necessity for an immediate and serious consideration of eugenic problems in all civilized countries. The proof of this necessity must be based on the laws of heredity, on the history of the changes in racial characteristics in the past, and on what is known concerning the effect of all the many biological and social factors which tend either to improve or de-

teriorate the innate qualities of mankind. If this field should be covered in a wide and comprehensive manner in the papers presented to the congress, including an adequate discussion of the general nature of the reforms, moral and legislative, necessary for insuring the progress of the race, the records of the proceedings would form a presentment of the case for eugenic reform which would assuredly be of great value to both the legislator and the social reformer. To achieve such a result should be the main object, rather than the attempt to make the congress an arena for the discussion of academic questions mainly of interest to scientific investigators.

THE Society for Biological Research of the University of Pittsburgh held the first of its special meetings for the year 1911-12 on December 14, at which time Dr. George Neil Stewart, professor of experimental medicine and director of the Cushing Laboratory at Western Reserve University, presented to the society the results of some of his recent work on the rate of the blood-flow in man. This plan of special lectures was inaugurated during the year 1910-11, by addresses on the "Hypophysis," by Dr. Harvey K. Cushing, of Johns Hopkins University, and on "Habit," by Dr. J. George Adami, of McGill University.

THE President of Venezuela has issued a decree creating a National Bureau of Sanitation. Under its auspices will be inaugurated an Institute of Hygiene, which will be composed of a laboratory of bacteriology and of parasitology, a veterinary department, and a central station of disinfection. The staff of the bureau will be composed of a director, a subdirector, a bacteriologist, an engineer, a biologist, a veterinary surgeon, an inspector general, two technical aids, a secretary and two laboratory assistants.

THE *Boston Transcript* states that a bill intended to give effect to the convention between the United States, Great Britain, Japan and Russia for the preservation and protection of the fur seals in the waters of the North Pacific Ocean will be considered by the house committee on foreign affairs very soon after

congress reconvenes. The treaty was concluded here last July and the final exchanges of ratifications between the governments ended two weeks ago. It now remains necessary only for the required legislation to be enacted. The bill to put the terms of the treaty into effect declares that no citizen of the United States shall kill or capture fur seals in the Pacific Ocean or seas of Bering, Kamschatka, Okhotsk or Japan north of the thirteenth parallel of north latitude, or kill sea otter in any of the waters beyond three miles from the United States shore line. Further, it is recited that no citizen of the United States shall equip or aid in equipping vessels to be used in pelagic sealing in these waters; that the importation of fur seal skins taken in those waters be prohibited except such as have been taken under authority of the respective governments parties to the convention to which the breeding grounds belong. Heavy penalties are provided by the bill for violations of its provisions.

The value of the total mineral output of Alaska in 1911 is estimated at \$20,370,000, compared with \$16,883,678 in 1910. The gold output in 1911 is estimated to have a value of \$17,150,000; that of 1910 was \$16,126,749. It is estimated that the Alaska mines produced 22,900,000 pounds of copper in 1911, valued at about \$2,830,000; in 1910 their output was 4,241,689 pounds, valued at \$538,695. The silver production in 1911 is estimated to have a value of \$220,000, compared with \$85,236 for 1910. The value of all other mineral products in 1911, including tin, marble, gypsum and coal, was about \$170,000, an increase over that of 1910. By using the above estimates for the output of 1911, the total value of Alaska's mineral production since 1880, when mining first began, is found to be, in round numbers, \$206,600,000, of which \$195,950,000 is represented by the value of the gold output. The total production of copper in Alaska since 1901, when systematic mining of this metal began, is about 56,700,000 pounds, valued at about \$8,170,000.

MR. N. HOLLISTER, assistant curator of the division of mammals, U. S. National Museum,

announces the discovery of four new animals from the Canadian Rockies, in a paper just published by the Smithsonian Institution. During last summer a small party of naturalists from the Smithsonian Institution accompanied the expedition of the Alpine Club of Canada, to the Mount Robson region, where they made the first natural history collection ever taken in that vicinity. The paper mentioned above is the first publication issued by the institution on this expedition, although Mr. J. H. Riley, a member of the party, has written a description of two new species of birds discovered on the trip, which has recently been published in the *Proceedings* of the Biological Society of Washington; both of the birds are of the sparrow family, one a song sparrow, and the other a fox sparrow. The natural history work of the expedition was under the charge of Mr. Hollister. He paid especial attention, however, to the mammals, four of which he describes, a chipmunk, a manteled ground-squirrel and two bats. All the specimens come from the neighborhood of Mount Robson, which lies in one of the wild and unexplored parts of British Columbia, at about 14,500 feet elevation.

THE Bureau of American Ethnology is preparing a new work which will form a "Handbook of Aboriginal Remains in the United States, and will have to do with the ancient abodes, camps, mounds, workshops, quarries, burial places, etc., of the Indian tribes. In connection with this work, Mr. F. W. Hodge, ethnologist in charge of the Bureau of American Ethnology, is sending letters of inquiry to all persons thought to have any knowledge of the subject of this undertaking, as well as to all institutions and societies interested in American archeology and ethnology. The letter requests all information respecting the location, character and history of the remains left by the Indians, or other indications of their former occupancy. In 1891 a catalogue of prehistoric works east of the Rocky Mountains was published, but that work is both out of date and out of print. It was compiled by Dr. Cyrus Thomas and

several collaborators. A large territory was covered in the first book and judging from the large map of the eastern United States, the parts of this country most densely populated by the aborigines must have been the basins of the Mississippi and Ohio rivers and the southern shores of the Great Lakes, although there are indications of many settlements on the Atlantic coast, especially in Florida. A large map showed all the locations, and smaller maps, of which there was one for each state, indicated the nature of each site by a special symbol. In the cartographic list, one found the meanings of the symbols readily; a single house drawn in outline represented a wooden lodge, while two houses represented a village; a grave was indicated by a special figure; a mound by the same figure reversed, and so on; enabling one, with a little study, to see at a glance exactly what was located at a certain point. It is not expected that the prospective work on Indian antiquities will be issued for many months. Following the precedent of the old report, the new one in completion, will show, to even a greater and more extensive end, all available information. It is proposed to classify the former Indian remains by states and counties, and to illustrate the publication with maps, photographs and drawings.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Edinburgh has received from the trustees of the estate of Mr. Robert Irvine the sum of £30,000, to establish a chair of bacteriology.

THE Cambridge council has voted the closing of the streets which cross the fifty acres of land fronting on the Charles River which the Massachusetts Institute of Technology proposes to purchase.

A NEW plan for the administration of the College of Agriculture, Cornell University, has been enacted by the university board of trustees to go into effect on January 1, 1912. The management of the college will be subject to the general supervision and control of the full board of trustees, and the immediate

supervision, instead of being in the hands of the executive committee of the board, as now, will be entrusted to a special committee of eleven persons to be known as the Agricultural College council. Director Bailey has consented to remain at the head of the college long enough to put the new plan in substantial operation.

THE Annual Farmers' Short Course at the University of Missouri will be given this year beginning January 8 and continuing throughout the week. It is planned to give six short courses on soils and farm crops, animal husbandry, farm management, dairy husbandry, horticulture and poultry husbandry. The class rooms and laboratories of the Agricultural College will be thrown open during this week to the farmers of Missouri. The entire teaching force of the college, consisting of more than forty men, will, by lecture and demonstration, give instruction in the subjects and will describe the experiments conducted by the Experiment Station. The state board of agriculture, cooperating with the college, has provided for the evening lectures. President K. L. Butterfield, of Massachusetts; Dean H. L. Russell, of Wisconsin; Jos. E. Wing, of Ohio; A. N. Abbott, of Illinois; Herbert Krum, of Kentucky; Uriel W. Lamkin, of Missouri, and many others will address the farmers. The annual Farmers' banquet, given by the College of Agriculture and consisting largely of products grown on the college farm, will be given Friday night, January 12. The beef will be from an international prize winner, the cream and butter from the Dairy Department and fruits and vegetables from the Department of Horticulture. Governor Herbert S. Hadley will be present during the week.

THE minister of education has laid before the Hungarian parliament a bill which provides for the erection of two new universities in Hungary, in the cities of Pressburg and Debreczin.

PROFESSOR E. G. MONTGOMERY, of Nebraska University, has been appointed professor of

farm crops in the College of Agriculture of Cornell University.

DR. H. BASSETT, of the University of Liverpool, has been appointed professor of chemistry at University College, Reading.

DR. W. R. BOYCE GIBSON, lecturer in philosophy at the University of Liverpool, has been appointed professor of mental and moral philosophy at the University of Melbourne.

DISCUSSION AND CORRESPONDENCE

"GENOTYPES," "BIOTYPES," "PURE LINES" AND "CLONES"

IN A recent issue of SCIENCE¹ Dr. Jennings calls attention to a double meaning which has been given to the word "genotype" by several recent writers, myself among them, and points out the desirability of limiting the word to the meaning assigned to it by its originator, Dr. Johannsen.

As one of the chief offenders, I wish to publicly repent my misuse of the term and to heartily join in the movement to limit the word "genotype" as used in the literature of genetics, to the fundamental hereditary constitution of an individual. The use of this word both for the hereditary constitution and for the group of individuals possessing an identical hereditary constitution, will lead to much confusion if continued.

The word which Dr. Jennings says is much needed "for a concrete, visible group of organisms" "all with the same hereditary characteristics," has been already supplied. In a symposium on the "Aspects of the Species Question" before the Botanical Society of America at Chicago, January 1, 1908, I pointed out² the same need and expressed a hope that some one would "come forward with an acceptable short designation" for these "elementary forms" which had been classified by de Vries as "elementary species" and "varieties." A few months later I discovered that my wish had been fulfilled before its utterance, by Dr. Johannsen, and his word "biotype"³ was immediately adopted in my

paper on "The Composition of a Field of Maize"⁴ and made a part of the title of my work on "*Bursa bursa-pastoris* and *Bursa Heegeri*: Biotypes and Hybrids."⁵ In view of these facts there was no excuse for my use of the word "genotype" in a taxonomic sense.

Dr. Jennings also calls attention to an important misuse of the expression "pure line," and here I must again admit a certain amount of guilt, as I was probably the first to include under this term groups of individuals related through the process of budding or any other method of vegetative reproduction. In 1904 I wrote:⁶

By the "pure line" Johannsen means a series of individuals related only through the process of self-fertilization. On *a priori* grounds it seems proper to apply the term to every series of individuals that do not combine elements of two or more ancestral lines through the equivalent of a sexual process. Thus, so far as hereditary qualities are concerned, there should be no reason to expect in a self-fertilizing population conditions different from those in a population related through budding or other method of vegetative reproduction, provided, of course, that the self-fertilizing population has not been so recently modified by a cross as to allow the analysis and recombination of characters derived from different ancestral lines.

For this early departure from "the narrow path" I have in part atoned in my recent paper on the "Genotypes of Maize,"⁷ by referring to the vegetatively reproduced potato and paramecium as "clonal varieties," in contradistinction to the self-fertilizing "pure

³ This word was first proposed in 1905 in "Arvelighedslærens Elementer," the Danish fore-runner of "Elemente der exakten Erbliehkeitslehre," and was first used in English at the Third International Conference on Genetics in 1906. (See Report Third International Conference on Genetics, p. 98, 1906.)

⁴ Report American Breeders' Association, IV., 296-301, 1908.

⁵ Carnegie Institution of Washington Publication No. 112, 1909.

⁶ *Torreya*, V., 22, February, 1905.

⁷ *Amer. Nat.*, XLV., 234-252, April, 1911.

¹ SCIENCE, December 15, 1911.

² *Amer. Nat.*, XLII., 278, May, 1908.

lines" of beans, barley, etc. I might equally well have called them simply "clones," as "clonal varieties" and "clones" should have identical meaning. The word "clone" (Greek κλων, a twig, spray, or slip) was proposed by Webber⁸ for "groups of plants that are propagated by the use of any form of vegetative parts, such as bulbs, tubers, cuttings, grafts, buds, etc., and which are simply parts of the same individual seedling." I believe that no violence will be done by extending this term to include animals which are similarly propagated by any asexual method, and I suggest the general adoption of the word "clone" for all groups of individuals having identical genotypic character,⁹ and arising by asexual reproduction of any sort, including apogamy (*i. e.*, so-called "parthenogenesis" unaccompanied by a reduction division).

For the purposes of my discussion in 1904 the distinction between "pure lines" and "clones" was of no consequence, because the particular hereditary principle then under consideration was common to both. The same thing is no doubt true of many of the recent investigations of others, but it is well to remember that there are certain fundamental differences between "pure lines" and "clones," which render it very important to maintain the distinction between them. I will mention but two of these differences by way of example: (1) In the "clone" it is possible to retain as a permanent feature of the group any purely heterozygous character, as for instance the vigorous constitution dependent upon the stimulation of heterozygosis; such a phenomenon is impossible in the "pure line." (2) When clonal individuals reproduce sexually, either by self-fertilization or by crossing with other individuals, they need not, and usually do not, produce genotypically equal offspring, because the individuals of the

⁸ SCIENCE, XVIII, 501-503, October 16, 1903. For a discussion of the spelling of the word "clone" see SCIENCE, XXII, 89, July 21, 1905.

⁹ This restriction is necessary in order to avoid confusion through the appearance of bud-mutations. Such a mutation if propagated vegetatively represents the origin of a new clone.

"clone" are not necessarily homozygous, as the individuals of the "pure line" generally are. The "clones" of horticultural plants are notorious for the heterogeneity of their seedling offspring. The investigator of intermittently parthenogenetic organisms like aphids, rotifers and Hieracium, and of intermittently vegetatively produced organisms like paramecium and many plants, can not properly assume that their races are genotypically pure in the sense that they are homozygous, while the worker with "pure lines" can make such assumption with small probability of error, in case his self-fertilizations have been controlled with adequate care during a sufficiently large number of generations.

There is another prevalent misconception regarding "pure lines," to which attention needs to be called. The word "pure" in this connection does not refer to the genotypic equality of the individuals, but only to the exclusion of all crossing as a source of genotypic differentiation.

In Dr. Harris's criticism¹⁰ of Roemer's work with peas, he points out with very evident satisfaction that two of Roemer's populations are historically traceable to individual selections and that they are therefore really "pure lines" (*i. e.*, providing, of course, that those originally selected individuals were strictly homozygous, and that no chance crossing has taken place since). If no genotypic changes can take place within the "pure line" all evolution is impossible in the large number of forms which naturally maintain "pure lines" by obligate self-fertilization. The only point to be made in regard to this feature of Roemer's results, is that, if his populations were really "pure lines," the numerous distinct biotypes he discovered by the "pure line" method in those populations, were the result of mutations which have taken place since the original selections were made. The occurrence of such mutations does not affect in the least the value of the genotype theory, nor the importance of the "pure line" method for the study of heredity.

¹⁰ Amer. Nat., XLV., 686-700, November, 1911.

Definitions:

Genotype, the fundamental hereditary constitution or combination of genes of an organism.

Biotype, a group of individuals possessing the same genotype.

Pure line, a group of individuals traceable through solely self-fertilized lines to a single homozygous ancestor.

Clone, a group of individuals of like genotypic constitution, traceable through asexual reproductions to a single ancestral zygote, or else perpetually asexual.

GEO. H. SHULL

HISTORY OF MATHEMATICS IN THE RECENT EDITION OF THE ENCYCLOPÆDIA BRITANNICA

THE new edition of the *Encyclopædia Britannica* contains numerous articles which purport to deal with the history of various branches of mathematics. None of these have been written by specialists in this field and the articles bear abundant evidence of this fact. The history of mathematics may well ask of the editors of such an encyclopedia the same care in the selection of writers on these topics as that exercised in the selection of writers in other fields, ably represented in general in the *Britannica* by the leading scholars of the world.

In a recent issue of *SCIENCE* (December 1, 1911) Professor G. A. Miller has called attention to certain inaccuracies and errors, especially with reference to the theory of numbers and of groups. It seems to me unfortunate, in view of the general worthlessness of the historical passages, that Professor Miller has incidentally chosen for criticism one of the few correct statements. The passage in question occurs on page 867 in volume XIX., in the article on "Numerals" in which the writer states that our present decimal system is of Indian origin. Attention is rightly called by Professor Miller to the fact that the zero appeared in Babylon long before it appeared in India, although the writer on "Numerals" seems to be unaware of this. However, the date is not 1700 B.C., as Professor

Miller states, but more than a thousand years later. Photographic reproduction of Babylonian tablets containing the zero appear in F. X. Kugler's "Die babylonische Mondrechnung," Freiburg i. Br., 1900, and these tablets date from the centuries just before the Christian era. Furthermore, no historian of mathematics has made the claim that modern arithmetic is derived from the Babylonian arithmetic, as Professor Miller implies, but there is general agreement that our arithmetic comes to us from the Hindus through the Arabic writer (c. 825 A.D.) Mohammed ben Musa Al-Khowarizmi. This subject is fully discussed in "The Hindu-Arabic Numerals," Smith and Karpinski, Boston, 1911.

The article on "The History of Mathematics," Vol. XVII., pp. 882-883, is too brief to invite comment. The incorrect statement is made: "The medieval Arabians invented our system of numeration." Reference is given only to the works of Cantor ("1st Bd.," "2d Bd." and "3d Bd.") and to W. W. R. Ball's "A Short History of Mathematics," London, 1888, and subsequent editions. The latter work is in no sense an authority on the subject.

The articles on "Algebra, History," Vol. I., pp. 616-620, and "Geometry, History," Vol. XI., pp. 675-677, contain so many inaccuracies and so much misinformation that selection becomes difficult. I will devote myself more particularly to the longer article on the history of algebra.

Some ridiculous statements made by Peter Ramus in his algebra of 1560 are quoted. Thus Ramus says: "There was a certain learned mathematician who sent his algebra, written in the Syriac language, to Alexander the Great, and he named it *almucabala*, that is, the book of dark or mysterious things, which others would rather call the doctrine of algebra . . . and by the Indians . . . it is called *aljabra* and *alboret*." This nonsense, evident on its face, as *almucabala* and *aljabra* are Arabic words, is taken somewhat seriously by this writer in the *Britannica*. "The uncertain authority," he says, "of these statements, and the plausibility of the preceding explana-

tion, have caused philologists to accept the derivation from *al* and *jabara*." The "preceding explanation," to which reference is made, is the correct one, viz., *algebra* from the first part of the title of Mohammed ben Musa's work on the subject.

Very evidently the writer has only second-hand information about the works of this great Arabic writer to whom the mathematical world is indebted for its knowledge of the Hindu numerals and also for the first systematic treatise on algebra. This is the more to be regretted, coming from Cambridge, since the unique copy of an early (twelfth century) Latin translation of Mohammed ben Musa Al-Khowarizmi's arithmetic is in a Cambridge library and the unique copy of the Arabic algebra is in Oxford and was translated into English in 1831 by F. Rosen. The arithmetic was published by Boncompagni, "Trattati d'Aritmetica," Rome, 1857. The writer in the Britannica regards the two as a single work and his comments on the indebtedness to Greek and Hindu sources are, of course, worthless.

Incorrect is the assertion that the thirteen books of Diophantus's "Arithmetica" are not lost, but this statement, it is only fair to say, may be due to a misprint. Bhaskara, a Hindu mathematician of the twelfth century, made great advances over the algebraic work of Brahmagupta (seventh century), although the Britannica states the contrary. John Pell's algebra of 1668 does not exist nor did he anywhere present the solution of the so-called Pellian, $x^2 - ay^2 = 1$. Pell did in 1668 have in print, simply under his initials, some comments on Brouncker's translation of Johann Heinrich Rahn's "Algebra." To Simon Stevin of Bruges is ascribed the publication of "an arithmetic in 1585 and an algebra shortly afterwards." Both were combined in one volume in 1585, as D. E. Smith shows in the "Rara Arithmetica," Boston, 1909, pp. 386-388. Stevin's fame as the first writer to give an exposition of decimal fractions seems not to be known to this writer, for the statement that Stevin "considerably simplified the notation for decimals" is wide of the mark.

Approaches to decimal fractions appeared before Stevin, but no exposition and no notation for Stevin to simplify.

The revival of the study of algebra in Christendom is incorrectly attributed to Leonard of Pisa (1202 A.D.). Robert of Chester, an Englishman living in Segovia, Spain, translated into Latin in 1145 A.D. the Arabic algebra of Mohammed ben Musa. Only a little later Gerard of Cremona treated the same work and about the same time Plato of Tivoli translated into Latin a work dealing with quadratic equations by Savasorda (twelfth century). The revival of mathematics in Christendom begins with these men and others who like them were occupying themselves with translations from the Arabic. The statement that the work of Leonard "contains little that is original, and although the work created a great sensation when it was first published, the effect soon passed away and the book was practically forgotten," is as false as it is ridiculous.

Now this writer turns immediately to discuss Luca Paciolo and then states: "These works are the earliest printed books on mathematics." How this glaring blunder "got by" the editors is difficult to understand. Leonard of Pisa's work was not in print until 1857, when Prince Baldassare Boncompagni published it and even Paciolo's "Summa de Arithmetica" did not appear until 1494. The first printed arithmetic is probably that of Treviso, 1478. Between that time and 1494 many important works appeared. No less than three editions of Pietro Borghi's arithmetic (1484, 1488 and 1491) and some six editions of the three different works on arithmetic by J. Widmann (1488, 1489, 1490, 1493), are included among these books. The Algorismus by John Halifax (Sacrobosco) appeared in two editions (1488 and 1490?). Philip Calandri published in 1491 an arithmetic with illustrated problems and Francesco Pellos (Pellizzati) got out an arithmetic in the year that Columbus discovered America. Peurbach's Algorismus (1492) and others could be added to this list.

The transliteration of Arabic names is en-

tirely original, as, for example, Tobit ben Korra for Thabit ben Qorra.

The most amusing statement is, "Fahri des al Karhi, who flourished about the beginning of the eleventh century, is the author of the most important Arabian work on algebra." Now Al-Fakhri, or Fakhri, is, indeed, the title of an Arabic work on algebra by one Abu Bekr Mohammed ibn Al-husain Al-Karkhi, or Al-Karkhi, for short. But the *des* seems, at first, unexplainable. The probability is that the *des* is German and some chance reference in German to the Fakhri des Al-Karkhi, the Fakhri of Al-Karkhi, undoubtedly accounts for this Farhi des Al Karhi.

Equally bad from a mathematical point of view is the surprising statement that "the Arabs accomplished the general solution of numerical equations."

The shorter article by the same writer on "Geometry, History," contains, of course, fewer errors. We must regard it as fortunate, in view of the errors I have shown and others not noted in the article on the history of algebra, that there is no article on the history of arithmetic. In pleasing contrast to these articles mentioned is the summary of the history of trigonometry by E. W. Hobson.

The one man best qualified to write a summary of the history of algebra and also of geometry is undoubtedly Sir Thomas L. Heath, sometime fellow of Trinity College, Cambridge. Even in 1910 the Cambridge University Press published a second edition of Heath's "Diophantus" and in 1908, Heath's "The Thirteen Books of Euclid's Elements," in three volumes. We may well express our surprise that the fame of Sir Thomas Heath should not be known to his Alma Mater, which stands sponsor for the encyclopedia, and that his aid was not sought for the history of mathematics in the Britannica.

L. C. KARPINSKI

ANN ARBOR, MICH.

DEVASTATION OF FORESTS IN THE WHITE MOUNTAINS

To those who have supposed that the Weeks bill for the preservation of the Appalachian

forests has settled a long-debated question, and that the advocates of the measure may now take a rest, secure in the belief that its execution is in the hands of a scientific man, armed both with authority and with knowledge, the article by Winthrop Packard in the *Boston Transcript* for October 7, 1911, stating the results of his exploration of the White Mountain region during the past summer will be a distinct shock.

"Lumbering," says Mr. Packard, "used to be a winter job, but there is no let-up in the rush now on to get the last spruce off the high levels of the White Mountains." The Weeks bill "is still about to work. But meanwhile the only part of it which is really working is the joker . . . which makes it indefinitely in-operative." An "innocent little paragraph in the Weeks bill says, in effect, that the head of the United States Geological Survey shall decide what areas are to be reserved along the head waters of the navigable rivers."

"Meanwhile, whether it affects the navigation of the Connecticut, the Androscoggin, the Saco and the Merrimac or not, the last of the good black growth of spruce, fir and hemlock is rapidly coming off the higher slopes of the Presidential Range and the lesser ranges that surround it."

"The best of the beautiful primeval forest is still above the high-water mark of this cutting, but it will take only a winter or two to encompass its downfall, and the investigations of the Geological Survey may probably be depended upon to hold the Weeks bill by the throat for that length of time, if not forever.

"The largest body of spruce left within sight of Mount Washington is that which lies at the head of the Rocky Branch Valley, between the Montalban Range on the west, the Rocky Branch Ridge on the east and Boott's Spur. . . . Here are some square miles of splendid black growth. . . . It is a virgin forest which one might suppose would last because of its inaccessibility. It is walled in by mountains on three sides and is sixteen miles up a tremendously rough valley from the south. This valley is drained by a tributary

of the Saco, a stream so capricious and boulder-strewn that it would be an impossibility to drive logs down it. But spruce and hemlock are exceedingly valuable nowadays, and, moreover, that Weeks bill threatens—or would threaten if it were not for that little joker—to prevent the slaughter of trees so near Mount Washington. So a lumber railroad has been driven with great energy up to the very center of this last refuge of the forest primeval."

In the Crawford Notch the cutting has been carried as far up as the Frankenstein Trestle. "The whole easterly slope of the Franconia Range and the valleys among the foothills of this range have been denuded. Indeed, from the summit of Lafayette almost all that the eye can see of the lower and western part of the Pemigewasset Valley has been swept clean and left a leafless, brown desert of slash. So from Carrigan Summit it shows on the southerly slopes of Bemis, Anderson, Lowell and Nancy."

It is evident from the above that the cutting of the forest is progressing at an unprecedented rate, and this, not merely on the lower and more gentle slopes where there is a possibility that the growth of spruce may be renewed, but also on the upper and steeper inclines where the forest, when once removed, is gone, if not forever, still at least until the next Ice Age wipes out the relics of human folly, renews the mantle of drift, and restores, after the recession of the ice, those climatic conditions which make the initiation of evergreen forests possible in such situations.

At the conference of governors, called by President Roosevelt to consider the conservation of our natural resources, after reciting the axiom: "The great natural resources supply the material basis upon which our civilization must continue to depend and upon which the perpetuity of the nation itself rests," the conference made the following unanimous declaration:

"We agree, in the light of the facts brought to our knowledge and from information received from sources which we can not doubt, that this material basis is threatened with

exhaustion. Even as each succeeding generation from the birth of the nation has performed its part in promoting the progress and development of the republic, so do we in this generation recognize it as a high duty to perform our part; and this duty in large degree lies in the adoption of measures for the conservation of the natural wealth of the country." It was further declared that "this conservation of our natural resources is a subject of transcendent importance, which should engage unremittently the attention of the nation, the states and the people in earnest cooperation."

All of this is matter for consideration in the light of science. As abstract questions, these declarations received universal acquiescence; but diversity of opinion arises in their application, and here we enter upon a sphere of action where science and politics must combine. Distasteful as it may be to men of science to enter into the sphere of politics, the lesson which the laborers have been slowly learning, that the needs of industry receive no attention until pushed to the center of the political arena, must apparently be taken home by science also.

One of the declarations of the governors reads: "That sources of national wealth exist for the benefit of the people, and that monopoly thereof should not be tolerated." Here this honorable body touches the crux of the whole matter.

As soon as remedial legislation is attempted, the forces of monopoly show themselves to be stronger than science, stronger than governors or presidents. In fact, there is only one power that is greater—that of the people. Whenever the nation becomes so thoroughly aroused that its people act together as one man, monopoly will be overthrown. Until that time arrives, there is need for science to continue a campaign of education and to continue it *unremittingly* as the governors advise.

After the first flush of enthusiasm has cooled, look for reaction and apparent back track to make way for the next wave of advance. The need of a new movement is

already immanent. Though the campaign of education may flag, the exploiters of the nation's resources, who act without regard to ultimate consequences and for self-interest only, anxious lest their special privileges may be curtailed, are not letting the grass grow under their feet.

It becomes necessary for men of science to reiterate the fundamental facts, which they can do in the present instance with the certainty that scientific prognostications anent the passing of the forest and its resulting woes can not be made too loud or too often. The American Association for the Advancement of Science, whose memorial in 1873 was one of the beginnings of the present conservation movement, could not do a better thing than to present at its coming session another memorial to Congress, recounting the lessons which the engineers have been learning.

Professor Willis L. Moore, in his report as Chief of the Weather Bureau for 1909-10 (p. 18) says: "After an elaborate research into all available data, the Weather Bureau, in company with many eminent engineers, concludes that on the principal rivers the floods are not higher or longer continued or the low water lower than forty years ago, while other persons hold to the opposite." Nothing whatever is said as to changes in forestation of the river-basins investigated during the forty years, a point on which Professor Swain has commented in his review¹ of another work by the same author. In the more thickly settled parts of the country, deforestation was already far advanced forty years ago. Attention to earlier records shows a very different condition.

Mr. Joseph B. Walker, writing in 1872, said that "the rapid destruction of the forests" of New Hampshire was then "painfully apparent everywhere"; and in 1891 the same author said: "The volumes of our streams are less

equable than formerly. In summer they are greatly reduced. Many brooks whose flow was once perennial are no longer to be found for one half of the year. This fact is due to the total or partial denudation of the land from which they flow. So serious an evil had this become, some thirty or forty years ago, that the manufacturing companies upon the lower part of the Merrimac were forced to construct vast storage reservoirs, at great expense, which can be drawn upon as water is wanted. Winnepesaukee Lake and Long Pond are two of these. Total denudation at the source of our streams would convert them into destructive torrents in spring and their channels into dry ditches for the rest of the year." The last is of course an inference, but one that is not improbable.

Similar occurrences have taken place in central New York. "With the clearing away of the forests and the burning of the forest floor came a failure of canal supply that necessitated the building of costly dams and reservoirs to replace the natural ones which the fire and axe had destroyed. The Mohawk River, which for years had fed the Erie Canal at Rome, failed to yield any longer a sufficient supply, whereupon the Black River was tapped at Forestport, and its whole volume at that point diverted southward to assist the Mohawk in its work." The reports of the superintendent of public works in New York State, thirty or more years back, reiterate the progressive failure of the water supply and appeal for the protection of the forests. We hear less of these complaints to-day simply because the railroads are in full control and many of the early canals are abandoned. But the time will surely come when this policy will be recognized as a mistake.

B. E. Fernow, in a paper on the "Relation of Forests to Water Supplies," writing in 1892,² cites the earlier changes in the Schuylkill River: "During the last sixty or sixty-five years," he says, "this river has shown a marked diminution in its *minimum* flow. In

¹ "The Influence of Forests on Climate and on Floods," a review of Professor Willis L. Moore's report, by George F. Swain, LL.D., professor of civil engineering, Harvard University, *American Forestry*, Vol. 16, pp. 224-240, April, 1910.

² Bulletin No. 7, Forestry Division, U. S. Department of Agriculture, 1893, p. 165.

1816 this flow was estimated at 500,000,000 gallons per day; in 1825 at 440,000,000; in 1867 at 400,000,000, and in 1874 at 245,000,000. In regard to this a commission of engineers say in their report in 1875: This remarkable decrease, not being accompanied by any great change in the rainfall, is no doubt largely due to the destruction of the forests in the drainage area, whereby the conservative action of the woodland has been lost, and the rainfall is permitted to descend rapidly to the bed and pass off in a succession of freshets."

The same bulletin (pp. 23-122) contains an elaborate "Review of Forest Meteorological Observations," by Professor Mark W. Harrington, who treats the data obtained at a considerable number of German stations by an original system of curves, bringing out the fact that the forest is cooler than the neighboring open country by several degrees. Being cooler, the dew-point is reached more quickly in the forest, when atmospheric conditions favor rain. The forest has (1) larger evaporation from widespread leafy surfaces and moist shaded soil, (2) cooler atmosphere from the local evaporation and (3) greater precipitation. Effects (1) and (3) so nearly compensate that there is hardly any difference in the total run-off from a given area, whether forested or not, but a great difference in the distribution of the flow in its annual fluctuation.

The forest question is not a meteorological problem, but one of soils, erosion and drainage. In France enormous sums of money are being expended in a toilsome effort to undo the mistakes of the past and to reforest the steep slopes. It seems strange that "eminent engineers" should not be aware of these facts, and that our country must repeat all of these unhappy blunders of older nations without profiting by their experience.

The French writer, Belgrand, quoted by Professor Swain, touches the heart of the matter when he says: "The forests diminish very notably the volume of earthy matter transported by the streams, because they prevent the erosion of the earth, and it must be

recognized that the impoverishment of the earth is much more to be deplored than the disasters caused by floods."

In the report of the chief of engineers, U. S. Army, for 1891 (p. 1107), Major Charles W. Raymond says: "The destruction of forests from the mountain crests and slopes of a watershed is undoubtedly the principal cause of the increase of the average magnitude of floods. The evidence collected during the last twenty-five years establishing this conclusion is well nigh overwhelming, and it is verified by repeated observations, not only in the mountains of Europe, but also in our own land"; and he refers to Colonel Torrelli, who "affirms as the result of careful observations that four fifths of the precipitation in forests is absorbed by the soil or detained by the surface of the ground to be gradually given up in springs and gentle rills, and only one fifth of the precipitation is delivered to the rivers rapidly enough to create floods. Upon the same slopes and surfaces denuded of their forests, the proportions are reversed. . . . That the destruction of the forests in mountainous watersheds is followed by disastrous floods where previously such floods were unknown is not a matter of theory, opinion or probability, but it is a well-established physical fact."

"In France, Italy, Germany and Austria the systematic planting of mountain slopes as a means of restoring lost fertility and preventing the inundations following the destruction of forests, is an established fact followed by results more satisfactory than the most sanguine anticipations."

The attempt to divert attention from the problem of the forest on the plea that it involves unsolved meteorological questions is an obscuring of the real question which concerns the soil. Governmental authority has been invoked ostensibly on account of increased difficulties and dangers to navigation of the rivers through neglect of their forest sources. Such perturbations of the streams do undoubtedly result from deforestation of the mountain slopes, but of far greater importance is the injury to the soil. The soil of

our native land should be even more sacred than its waters, and if necessary the constitution should be amended to enable the Congress to pass laws protecting the soil as well as the waters of our common heritage.

FRANK W. VERY

WESTWOOD, MASS.,
November 25, 1911

SCIENTIFIC BOOKS

Characteristics of Existing Glaciers. By WILLIAM HERBERT HOBBS. New York, The Macmillan Company. 1911. Pp. ix + 301.

The author tells us that the book consists of three articles, more or less amplified, which he has contributed to scientific magazines. This explains the general character of the book, which is divided into three parts; the first deals principally with glacial erosion; the second with the ice masses of the Arctics and the third with those of the Antarctic. The subject is treated in regard to some of its larger aspects, such as geographical distribution, the general forms and the meteorological relations of the ice masses. The physical character of the ice which controls its movements, the relation of reservoir to dissipator, the formation of moraines and many other details are absent, as might be expected from what has been said above. On the other hand, far more space is given to the question of erosion and to meteorological conditions than is usual in books about glaciers.

In the first part, the subject of glacial erosion, both at the bottom of the valley and in the cirque wall, is considered. Here, for the first time, accounts of Matthes's theory of nivation and Willard D. Johnson's theory of bergschrund sapping are given to the general public. The author rejects Richter's idea of sapping just above the level of the *névé*, because it would produce a broad shelf, which has not been discovered; but he accepts Johnson's theory, though this method would also produce a shelf at a level only 150 or 200 feet lower. He has, however, presented convincing evidence to show that the cirque is enlarged by sapping and that the forms with which we are familiar in glaciated mountains

are the result of the extension of cirques by glacier erosion.

There are many ways of classifying glaciers, according to the characteristics one desires to emphasize. The author classifies glaciers in accordance with the amount of alimentation, and brings out some interesting relationships of the different forms; but it seems that, in this matter, he has not put sufficient emphasis upon underlying topography.

The accounts of the Arctics and the Antarctic are particularly interesting; the author has evidently studied the reports of all the explorers and has brought them together in a very readable form and in such a way as to give an excellent general survey of those distant regions. He insists that there are very marked fundamental differences between the character of alimentation in the polar regions and in temperate zones. In the latter, the precipitation is due to moist winds being raised to cold altitudes by the mountains themselves and then precipitating their moisture in the form of snow. In the polar regions Professor Hobbs thinks that there are no surface air currents blowing across the great ice masses from the adjacent seas. It has been made out that over Greenland and over the Antarctic there are great regions of high barometer; and the reports of explorers show that they almost invariably encountered winds blowing off the surface of the ice, and when these winds attained a fair strength they carried with them many fine particles of snow which were swept along for considerable distances. These outward air currents Professor Hobbs ascribes to the cooling and consequently increased density of the air by contact with the cold surfaces, followed by the air sliding off the great ice cap in all directions. This, of course, requires that the return currents should flow in at a higher altitude, and sink down upon the ice from above. These currents, which bring but little moisture, are heated dynamically as they sink, melting and evaporating whatever ice spicules they may be carrying, and the vapor is again frozen as it approaches the ice surface. In this way he accounts for the falling snows under clear

skies, which have been described by Arctic explorers. In the Arctics there is always a fringe around the ice masses where the winter's snow is all melted during the summer. In the Antarctica this is not the case, as the snow line extends quite to the sea level. The discussion of the various forms of ice masses and the formation and appearance of icebergs is most interesting. Glacialists will find much to interest them in this book and also many explanations with which they will not agree. For instance, the author thinks that the alimention of the Arctic ice occurs largely at its borders and is due to the snow being driven off the ice cap by the wind and piling up, around the edges, forming a convex surface, like a sand dune; it is hard to reconcile this with retreating glaciation. Also, the figure on page 139 would hardly have been inserted if the author had carefully considered the lines of flow of glacier ice.

The book is profusely illustrated and the illustrations elucidate the text; every one of them is referred to and they make the descriptions very vivid without the use of too many words. The reproduction, on the same scale, of plans of a number of glaciers, in plate 11, and Fig. 134, is very instructive. The numerous references at the end of every chapter will be very acceptable to those who desire to consult the original articles.

HARRY FIELDING REID

Fortschritte der Mineralogie, Kristallographie und Petrographie, herausgegeben im Auftrag der Deutschen Mineralogischen Gesellschaft, von DR. G. LINCK, Jena. Gustav Fischer, Jena, 1911. Pp. 290.

The German Mineralogical Society has undertaken to publish annually a report of progress in various fields of investigation related to mineralogy. This interesting first volume gives promise of a successful series. Dr. Linck is editor in virtue of his office as secretary of the society; the authors of the papers are specialists in their various fields and the presentation is intended to be popular. The varied subject matter shows how wide is the field to be covered. There are

twelve reports as follows. H. Baumhauer (Freiburg) treats of the Law of Complication and the Development of Crystal Faces in Complex Zones, accepting and elaborating Goldschmidt's work (17 pp.); O. Mügge (Göttingen), On the Twin Structures of Crystals (30 pp.), and F. Becke (Vienna), On the Formation of Twin Crystals (18 pp.), discuss very fully modern points of view as to definition and development of twinning; A. Ritzel (Jena) treats of the recent literature on Velocity of Crystal Growth and Solution (13 pp.). Under the heading Mineralogy, R. Marc (Jena) summarizes the literature on the Phase Rule and its Application to Mineralogical Questions (30 pp.); R. Brauns (Bonn) deals with the Causes of the Color of Faintly Colored Minerals and the Effect of Radium Rays upon the Color (12 pp.); A. Bergeat (Königsberg), reviewing the Genetic Interpretation of the North- and Middle Swedish Iron-ore Deposits in Recent Literature (18 pp.), shows the modern tendency towards regarding them as of magmatic origin; A. Schwantke (Marburg) gives a descriptive list of new minerals which have been described since 1898, arranged alphabetically without references to literature (20 pp.). Under the heading Petrography, F. Rinne (Leipzig), on Saltpetrography and Metallography in the Service of the Study of Eruptive Rocks (87 pp.), shows the bearing of such physico-chemical investigations as those of van't Hoff on the Stassfurt salt deposits upon the interpretation of processes of crystallization in igneous magmas; F. Becke (Vienna), in *Advances in the Province of Metamorphism* (36 pp.), reviews 87 papers which have dealt with this subject in the past three years. Under Meteorites, F. Berwerth (Vienna), *Advances in the Knowledge of Meteorites since 1900* (28 pp.), gives a complete bibliography of 394 entries, covering what has appeared on meteorites since the publication of Wülfing's book, together with critical reviews of many papers. Lastly H. E. Boeke (Halle) gives a brief account of the work of van't Hoff, especially as it bears upon mineralogy and geology.

The book is sent free to members of the society and is also on sale through dealers.

C. PALACHE

Nature Sketches in Temperate America. By JOSEPH LANE HANCOCK. Chicago: A. C. McClurg & Co. 1911. Pp. xvii + 451, 12 col. pls., 215 figs.

The preface of this attractive book says that it is a "popular exposition of the facts gleaned from nature" which often presents the subject "from the artistic or æsthetic point of view. This method does not sacrifice truth, which is the religion of science, but mitigates it, bringing about a wider reading circle. . . . More consideration is given to insects than to other groups of animals" and "the relation of animals and plants to their natural surroundings has been kept constantly in mind." The bearing of the subject matter on the theory of evolution is also considered in some detail.

Chapter 1 is devoted to "Evolution and Natural Selection." It gives a brief but complete discussion of the most generally accepted ideas concerning evolution and heredity with a few notes concerning their bearing on the subjects under consideration. Chapter 2 takes up "Adaptations in Plants and Animals, with Examples" and presents some interesting cases of particular adaptations—such as: how the milkweed profits by the visits of its insect guests; bird flowers; and the seasonal procession of flowers, insects and birds. Chapter 3 begins with a brief discussion of the theories of protective resemblance; the tree toad is next described, and the writer then takes up the walking-stick and various other insects and insect larvæ that are protected by their form, color or behavior. Chapter 4 is devoted to mimicry, and after discussing Bates's, Müller's and other theories, describes the monarch and viceroy butterflies, a bumble-bee and a robber-fly, and flower-frequenting flies. Chapter 5 takes up Wallace's theory of warning colors and then passes to a consideration of several bright colored lepidoptera and lepidopterous larvæ. Under the title "Animal Behavior, with Examples,"

Chapter 6 is opened with a brief statement of the author's ideas on instinct and intelligence and a table showing the distribution of sense organs in insects; then follow brief descriptions of the habits of many insects, spiders and birds. Chapter 7 is devoted to "General Observations and Sketches Afield." It considers: the formulation of problems, origin by adaptation in nature, ponds, brooks, meadows, the bumble-bees' night camp, etc. The title of Chapter 8 is "Ecology—Interpretation of Environment as Exemplified in the Orthoptera." In it are discussed the sources of life after glaciation, habitats of plants and animals, zoogeography, nature's reclamation of sterile ground, and various things concerning a number of Orthoptera. The last chapter consists of two parts: (1) a "classified list of habits of various species of Orthoptera based on their egg-laying sites, to show their relation to plant formations in general" (which follows the classifications used by some plant ecologists) and (2) "definitions of common environmental complexes, grouped under formations," in which seventy-six terms (including ocean, sea, lake, pond, pool, stagnant water, snow, alkali, sterile and man's houses) are defined.

The book contains many interesting descriptions of the habits of animals. Among the best of these the parts of chapters on the habits of the walking-stick, the castle-building spider, the golden SpheX as the grasshopper's enemy and the habits of the green meadow grasshopper, may be mentioned. An excellent picture is presented of the life of the animals discussed. The colored plates are excellent, and the same is true of many of the photographic plate illustrations, but some of the latter are so dark that they fail to show the points they are intended to demonstrate.

Hancock presents the theories of natural selection, mimicry and warning coloration in a rather dogmatic fashion and follows them with examples which have not always been indubitably proven to have been brought about in the way he intimates. A reader unfamiliar with the field might easily believe that these dogmas had never been disputed,

for the theories and examples are presented with little comment and the writer is "satisfied to let the reader draw his own conclusions." With what Hancock gives, the reader would doubtless conclude that everything was readily explained by the theories presented—though by this method the theories have the advantage of being clearly and definitely formulated. The reader is rather disappointed when he finds that the hundred-page chapter headed "Ecology—Interpretation of Environment as Exemplified in the Orthoptera" consists mostly of short descriptions of the habits of grasshoppers, and he looks in vain for the "interpretation."

The general reader will probably be confused where such terms as lores, calamus, rachis, vanes, barbs, barbules (p. 46) and luna (p. 60) are introduced without explanation. There is frequent and somewhat monotonous allusion to a "plate photographic illustration" which is often several pages from the reference. The reader would have been saved much time by a page reference. At the top of page 384 reference is made to a plate that appeared in the *American Naturalist* in 1905 but does not appear in the book! Among other loose and careless statements, such as are likely to appear in any first edition, the following may be mentioned: Humming birds are said to occur "in the tropics" and they are found only in America (p. 43). On pages 73 and 75 "this species" is discussed when no species has been mentioned; on page 86 the pronoun "them" refers to "substance." The following sentence occurs on page 299: "The cherries were luciously ripe, and after eating a few, one is apt to feel a dislike for their pungent flavor." "Geophilous" is used to designate animals that feed on the surface of the ground (p. 356), and one wonders how an animal like the earthworm, that eats dirt, would be classified. These definitions are given (pp. 432 and 433): "Desert: Vast sandy tracts of land, appearing in western United States, where evaporation exceeds rainfall. . . . Man's Houses: Country and City Houses; (a) basement; (b) upper floor."

Rana catesbiana appears on page 300 as *R. catibiana* and on the plate facing this page as *R. catibiani*. It is difficult to understand the writer's meaning when (p. 356), after stating that short-winged acridians are less numerous in treeless, arid districts than in humid, forested regions and that most flightless species of locusts are plant-feeding as distinguished from ground-feeding, he says: "My own conclusions . . . is simply this: that it is a question of food supply and nutrition derived therefrom. In the case of short-winged forms, they are due to under-development as the result of scant food."

A. S. PEARSE

SPECIAL ARTICLES

ON POWERS OF TEN

FOR expressing numerically the widely varying magnitudes occurring in scientific work, two methods are in common use. Both are adequate and accurate, but results expressed by means of one are much more easily grasped and remembered than with the other. The more convenient method appears to be gaining in use. The present paper is written with the idea that this desirable change may be accelerated if the advantages of the method are stated, and thus presented to those who have hitherto not given the matter special attention.

The simplest way of writing a number is, of course, to write it out in Arabic notation. But this, in general, involves the presence of numerous ciphers, which the reader must count in order to learn what the number is. There is, therefore, a gain if the writer counts the ciphers for him and records the number obtained. Hence the familiar system, where a number is given as the product of (1) a series of significant digits, and (2) ten, with an exponent (e. g., the velocity of light is 3×10^9 cm. per sec.).

This system has still one great disadvantage: it calls in each case for the reading of two numbers, and thus greatly increases the strain on both the attention and the memory. And this difficulty is multiplied when the

quantity expressed is less than unity, as it is about half the time. For then the exponent is negative, and the two numbers affect the resultant magnitude in opposite ways.

For instance, suppose a galvanometer which requires 3×10^{-8} amperes to give unit deflections: how will its sensitiveness compare with that of one for which both indicating numbers are numerically larger, say, 8.0×10^{-6} amperes? The larger significant figure, 8.0, indicates a larger current, and therefore less sensitiveness, but the exponent, 9, though also larger, indicates greater sensitiveness. Really, the second is about four times as sensitive as the first, but this fact is far from evident on a first reading; yet this is a very simple case. If a reader should see an account of one of these instruments on a Friday, and of the other on, say, the next Wednesday, it would require unusually careful reading indeed to leave him with any definite idea of the relative sensitiveness.

The difficulty of this system can also be well stated as follows: When a number of magnitudes, say diameters of small rods, is stated, sometimes in centimeters and sometimes in millimeters, it is evident that a good deal of unnecessary difficulty results, which can be avoided by sticking to one unit or the other. Now, between a millimeter and a centimeter there is the same difference as between any two consecutive powers of ten. An unrestricted system of notation by powers of ten, therefore, amounts practically to an unnecessary multiplication of the number of working units.

The remedy is obvious—to diminish the number of units. This is realized in the other system, which proceeds by steps of 1,000, instead of 10. A further gain is sometimes secured by using prefixes instead of exponents to indicate the working units, since the combination of a word and a number is preferable to two numbers, each of which interferes with the apprehension of the other, and even more with its recollection. This system is perhaps seen at its best in the field of electricity, where, besides the units, ampere, ohm, volt,

etc., the milliamper, millivolt, microampere, microvolt, kilowatt, megohm, etc., are in common use, and have almost completely displaced the reckoning by powers of ten. The advantages of the system have been made available in stating galvanometer sensitiveness by the scheme proposed by Ayrton. The sensitiveness is simply put equal to the deflection produced by a unit current, usually the microampere. According to this scheme, the sensitiveness of one of the galvanometers mentioned above is 125, of the other, 33. Here the difficulty of remembering or comparing the two quantities would seem to be reduced to the minimum. And this illustration gives a fair idea of the value of the general method. Under it, but one thing claims attention: a single number, which need never exceed 3 digits unless the accuracy attained calls for a larger number of significant figures. Such a number is relatively easy to comprehend and to remember. The unit needs almost no attention, since all magnitudes between which a comparison is likely to be desirable will be expressed either in the same unit, or else in units so far apart that no confusion will occur.

This choice of units is, of course, the essential part of the method, and it, of course, can be realized under the form of the notation by powers of ten by those to whom that form seems desirable. All that is necessary is that those powers of ten shall be chosen which are also powers of 1,000, so that the use of 10^3 , 10^4 , 10^5 , 10^6 , 10^{-2} , etc., is to be discontinued. But the use of the prefixes to denote the units seems decidedly preferable. The electrician who should be advised to abandon his microvolts and milliamperes, and go back to "volts $\times 10^{-6}$," etc., would scarcely be profoundly impressed with the value of the advice.

A few special points seem worth noticing in this connection.

A single prefix to denote 10^{-6} seems desirable. Until it appears, 10^{-6} amperes (for instance) should of course be called a millimicroampere. "Micro-micro," of course, means a millionth of a millionth, or 10^{-12} , and is illogical when used for 10^{-6} , besides

being less euphonic than the other. But it may be too late to stop the illogical use of $\mu\mu$ for the millimicron ($m\mu$) in the domain of optics.

There will undoubtedly be a tendency, as reckoning by powers of 1,000 comes more into use, for work in each particular line to be always expressed in the same derived unit. Here the advantage of a common unit more than compensates for the fact that in some particular cases the unit is not quite the most convenient. For instance, workers with thermoelements have generally found it advantageous to work in microvolts, and to keep to this unit even when the number of microvolts is over 10,000, that is, more than 10 millivolts.

In case of doubt between two units, it is probably better to use the smaller. For this diminishes the use of fractions, and also gives records more likely to be concordant with future work, since the increase of accuracy as time goes on increases the advantage of the lower unit.

In no class of quantities is more to be gained by reckoning by powers of 1,000 than with coefficients of expansion, and temperature and pressure coefficients generally. If these quantities were always tabulated in thousandths or millionths, instead of with a variable number of zeros, according to the fancy or convenience of the tabulator, a very much larger number of them would actually lie in the memory of the average working experimenter than are now to be found there. Yet these quantities, and some others, being pure numbers, have no special name, and therefore nothing to which the prefixes, milli-, micro-, etc., can be attached. They may legitimately be designated as "parts per mille," "parts per million," etc., but these expressions are rather awkward, particularly when the whole expression is "parts per mille per degree," or something like that. It would be convenient to use the fractional prefixes alone as nouns in such cases, milli meaning one part per thousand, and micro, one part per million. There is certainly considerable reason to wish that some leader, or committee, having sufficient

authority, would authorize the use in this way of these terms (or something better). They have these advantages: They are brief; they would harmonize with the terms used for other physical quantities; they would tend to extend the use of powers of 1,000. For instance, at present, most observers, working to an accuracy of (say) 10 parts per million, would prefer to state it as one part per 100,000, while with the word "micro" in use the almost universal expression would be 10 micros. And the use of powers of 1,000 is quite as desirable in stating errors, etc., as in most other cases.

The use of fractional or multiple prefixes also sounds a little strange in those cases where, in order to adhere strictly to the C.G.S. system, the centimeter is used as the unit of all linear measurements. The real difficulty here, however, does not lie in the prefixes, but in the fact that two different fundamental units, the meter and centimeter, are in use, and that most physicists are probably more used to measuring small lengths in millimeters and microns. This difficulty would not be increased by the use of the term millicentimeter and microcentimeter, which are of course the logical terms to use if the centimeter is to become the practical unit of all lengths. It also seems logical to use the centimeter only where such other C.G.S. units as the absolute electrostatic and electromagnetic units would be used, and to use the millimeter and micron in cases corresponding to those where the ampere, ohm and volt would be considered appropriate.

In any case, it may be well to repeat, the main and essential advantage of the newer system that is coming into use is in the restriction of notation to powers of ten which are also powers of 1,000. And this restriction can profitably be adopted whatever may be thought or done regarding the other points mentioned in this paper.

W. P. WHITE

GEOPHYSICAL LABORATORY,
CARNEGIE INSTITUTION OF WASHINGTON,
WASHINGTON, D. C.,
November 1, 1911

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SCIENCE

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AERIAL ENGINEERING¹

THE attention of the section was directed to aeronautics as long ago as 1886, when my distinguished predecessor, Octave Chanute, in his address at Buffalo, mentioned the possibilities of aerial navigation, a subject which entirely absorbed his later years and which he lived to see completely realized. Again in 1904, Professor C. M. Woodward devoted a portion of his vice-presidential address at Philadelphia to a consideration of the navigation of the air, which at that time had been accomplished with dirigible balloons. Papers on aeronautical subjects, or relating thereto, have been presented in increasing numbers to the section, reaching a maximum of eleven in 1909. Last year, the writer, as chairman of the section, made a special effort to secure such papers through a preliminary circular, thus worded:

The rapid advance in the navigation of the air during the past year has attracted serious attention to scientific aeronautics. The construction of dirigible balloons and flying machines is essentially a mechanical problem and as such merits consideration by this section, especially since no engineering society has yet taken this action. Accordingly papers are invited relating to aerodynamics and other branches of aeronautics and also discussing possible courses of instruction in colleges and technical schools.

As a result ten papers were presented and an aeronautical curriculum was for the first time discussed here.

The subject of this address, "Aerial

¹ Address of the vice-president and chairman of Section D—Mechanical Science and Engineering. Washington, 1911.

Engineering," suggests a new field for the profession, analogous to marine engineering and which may in the future prove almost as important. So long as the spherical balloon was the sole method of rising in the air, the technical questions involved belonged to physics and chemistry rather than to engineering, but with the advent of the dirigible balloon and the aeroplane, the mechanical engineer was called upon to provide the lightest possible motive-power and to design the framework of the balloon and the supporting surface of the aeroplane to sustain the greatest stresses with the least weight.

The determination of the meteorological conditions at different heights and places and under all weather conditions belongs to the meteorologist and his observations originally made in the interest of pure science now become of practical value. The necessity of knowing the conditions which may be encountered by air-craft in their voyages through space of three dimensions will ultimately lead to the construction of flying charts at different levels but otherwise similar to the sailing charts for the ocean. A beginning has already been made by the writer, who has published a series of twenty-four charts based on material collected by the Blue Hill Observatory in the United States and over the Atlantic Ocean. Since in the air as on the earth it is not the average, but the individual thing, which happens, an attempt is made to specialize for the time of day and season and also to show the sequence of wind-changes aloft which accompany different barometric conditions at the ground. A knowledge of the wind, which varies with both place and level and depends upon the meteorological situation, has a far greater importance for the airman than for the navigator, whose vessel rests on a dense and relatively stationary

medium. In general, the velocity of the wind increases with height and its direction becomes more constant, but the observations at Blue Hill seem to indicate that the gusts of wind, while increasing with the average velocity, decrease as we rise in the free air and are greatest near the ground in northwest winds, where they may be double the average speed. In experiments there by Mr. S. P. Fergusson, as many as ten pulsations per second were recorded by the most sensitive anemometers on a wide time-sheet. The uprush of air under cumulus clouds, which are especially strong when they become cumulo-nimbus or thunder-clouds, are dangerous to all aircraft that depend on dynamic equilibrium, as are the eddies termed by aviators "holes in the air," which are produced by superposed currents having different velocities or directions. It is possible for an aeroplane to fall when traveling with the wind if the gust greatly outstrips the mean velocity of the current that carries the aeroplane, which our experiments show to be a frequent occurrence, because its relative motion through the air, due to its motor, and therefore the upward component which furnishes support, is decreased by the inertia of the flying-machine preventing it from responding to the sudden impulse. The same thing may happen when going against the wind if a sudden lull occur, and if the aeroplane pass abruptly up or down into another air stratum of different velocity. Such local currents and atmospheric eddies, which have long been known to meteorologists from the behavior of their kites and balloons, will now be studied *in situ* and with danger by the aviator. Some of these disturbances may be counteracted by automatic control of equilibrium, but generally by increasing the speed and size of the machine and so rendering it less susceptible to the influence of those per-

turbations of the atmosphere which are of limited extent and duration. To-day the most needed improvements in aeroplanes are stability in wind-eddies and safety in landing.

The meteorological phenomena causing these difficulties are discussed here at some length because their solution belongs to mechanical science and therefore merits the attention of our best engineers. There is an erroneous idea that the aeroplane has been developed without laboratory experiments and that a study of the theory of flight, and hence the science of aviation, does not require theoretical knowledge of the different factors which influence it. The pioneers in aviation, Lilienthal, Maxim, Langley and the Wrights, experimented in the laboratory with surfaces exposed in wind-tunnels and on whirling-tables, and the best shapes for balloon-envelopes to present the minimum resistance to propulsion were also obtained from models. Theoretical knowledge based on experiments is indispensable to the aeronautical engineer as distinguished from the aviator. Only on such a foundation can we build up the new science of aeronautics and a technology which is indispensable for the development of this new branch of engineering.

M. Eiffel, the distinguished engineer, in describing the results of his recent work in aerodynamics says:

It must be admitted that the experiments in the laboratory with small models can furnish data useful to aeronautical constructors, saving them both money and time in experimenting. For a series of laboratory experiments made on model aeroplanes, or on wings of small size, which can be quickly and surely modified, gives the basis for later computation, either for the section of the different members depending on the strength of the material used, or for the conditions of equilibrium and stability, having regard to the calculated or assumed weight for each member. The same thing applies to a model of a screw-propeller

which tried under proper conditions may give information about the action of the actual propeller. The experiments with full-sized aeroplanes are almost always disturbed by wind, which introduces very large causes of error, and the trials being made necessarily with new apparatus of uncertain operation are generally dangerous. On the other hand, laboratory experiments can be conducted at any time and under different conditions and their results enable the knowledge of the engineer to replace the inspiration of the constructor, which in new fields may sometimes lead to fortunate discoveries, but may also give rise to costly mistakes.

The establishment of aerodynamical laboratories, therefore, marks the entrance of aeronautics into the domain of engineering. Probably the first of these was organized by Captain, later Colonel, Charles Renard at the Central Establishment for Military Aeronautics at Chalais-Meudon, near Paris, about 1884. Here important investigations on light motors and the resistance of bodies of different shapes to motion through the air were conducted, which resulted in the first successful dirigible balloon, *La France*. Experiments upon lifting screw-propellers, with a view to aviation, followed, and Colonel Renard carried on similar work until 1903, when he was succeeded by other officers and the name of the laboratory changed.

Important experiments on the resistance of the air to falling bodies were made between 1903 and 1906 by the eminent constructor of the Eiffel Tower there and later at his laboratory provided with a large wind-chamber on the Champs de Mars. Of great importance are the determination of the relations between the velocity and pressure of the air on a normal plane and upon plane and other surfaces at varying angles of incidence, the distribution of the pressure over the surface and the tests of aeroplane-wings. The results of the experiments have been published in two large volumes with the detail and elegance characteristic of M. Eiffel.

Another experimental establishment of wider scope has recently been created in France through the generosity of a patron of aeronautics, M. Deutsch de la Meurthe. This is the Aerotechnical Institute of the University of Paris, located at Saint Cyr, near the Buc aerodrome and the Satory camp, the center of military aeronautics in France. It is planned to study all theoretical and practical problems of aviation and aerostation relative to the support of bodies in the air, both at rest and in motion. The institute is primarily a testing establishment where constructors and experimenters may bring aeroplanes, or their parts, to be tested by the best devices at actual cost; and secondarily it is an institution where aerodynamics is studied in theory and in practice by experts for the government and some of the results are published as an aid to the science. The invested capital is \$100,000 and an additional annual income of \$3,000 is provided by M. Deutsch. The director of the institute is Professor Maurain, who has an advisory committee composed of eminent French scientific and aeronautical experts, including representatives of the University of Paris and the Aero-Club of France and government officials.

An earlier laboratory of the same nature in Russia was the Aerodynamic Institute of Koutchino, founded in 1904 by M. Riabouchinski in connection with the University of Moscow. Its object is to investigate problems of pure and applied aerodynamics, general aeronautics and meteorology and three volumes containing results of the valuable investigations have been published. The initial cost of the plant was about \$77,000 and the proprietor further donates some \$27,000 a year for the researches.

An aerodynamic laboratory was established at Göttingen, Germany, in 1908,

through the initiative of the Society for the Study of Motor Air-ships, aided by the Göttingen Technical Association, the government and the Krupp gun-firm, the laboratory receiving in the aggregate more than \$7,000 a year. Professor Prandtl, who also holds the chair of aeronautics in the University of Göttingen, is director of the laboratory, and has as advisers Germans prominent in physics and engineering. In Austria there are at least two private experimental laboratories.

The National Physical Laboratory at Bushy Park, near London, now has an aerodynamical department with an advisory board composed of men eminent in different branches of science, Lord Rayleigh being the chairman, who are appointed by the prime minister. The experimental apparatus for investigating general questions in aerodynamics includes a wind-tunnel, a whirling-table, two wind-towers for experiments in the natural wind, a motor-plant and arrangements for testing the permeability of balloon and aeroplane fabrics and the strength of light alloys for construction. A report of the advisory committee for 1909-10 has been published as a government blue book.

There is a well-equipped laboratory in Italy for the military aeronauts and in other European countries similar establishments exist, the work of which is not disclosed.

From this rapid survey of the principal scientific establishments for the study of aeronautics in Europe, it will be seen that they may be divided into two classes: first, those privately endowed laboratories, which are either personal or connected with some institution but whose object is the advancement of the science and practice of aeronautics; and second, those supported by the government for military

purposes, but which may publish data of value to constructors and students.

Instruction in aeronautics is now given in many foreign technical schools and universities, the best known course of study being under Professor Prandtl at the University of Göttingen, in connection with the laboratory already mentioned. M. Basil Zaharon, a wealthy Greek residing in Paris, has endowed a chair of aeronautics at the Sorbonne with a fund of \$140,000, so that France will soon rival Germany in facilities for training students in this science.

The United States is almost absolutely lacking to-day in aeronautical laboratories and technical instruction, for the brilliant researches in the past of Langley, Zahm and Nipher have not been followed by similar work since the flying machine was realized. Our government maintains no aerodynamic laboratory and few of our technical schools or colleges possess apparatus for this purpose, while none offer regular instruction though some investigations have been made by advanced students. The instruction in flying by the so-called aviation schools is, of course, unworthy of consideration, since the best of these only teach the aviator to operate and repair his machine as the automobile school does the chauffeur.

It appears likely that the demand for collegiate instruction from young men wishing to enter aerial engineering as a profession will soon require the establishment of regular courses of study based on the European curriculum, at the completion of which a degree or certificate of proficiency shall be given, ranking with that conferred in other professional courses. It seems to the writer that aerial engineering can best be taught in institutions that now possess departments of mechanical engineering and naval archi-

tecture, for the preliminary training would be the same as that now given in these studies and the specialization would consist in the substitution of air for water as the navigable medium. The installation of laboratories having powerful blowers connected with large wind-tunnels, or equipped with whirling-tables in a large enclosed space, is, of course, essential.

The board of governors of the Aero Club of America have requested the committee on aerodynamics to consider the most feasible method of organizing and maintaining an aeronautical laboratory in this country. This committee, of which the writer is a member, through its chairman, Dr. A. F. Zahm, has made a preliminary report containing the following suggestions. The fact that the United States Signal Corps and the Bureau of Navigation of the Navy Department will probably establish such laboratories for their officers, should not prevent the creation of a civil aeronautical institution similar to those already described in England, Germany and Russia. If the English precedent is followed, and the laboratory be maintained by the government, it could properly be attached to the Bureau of Standards, but if privately endowed, like those on the continent of Europe, it might become an adjunct of the Smithsonian Institution, and this would be the more appropriate because the institution through its late secretary has already undertaken extensive aerodynamical researches and still possesses workshops and a special library.

Two years ago our chairman, Professor G. F. Swain, in speaking of engineering as a profession, remarked that aeronautics was a peculiarly appropriate field for this section to occupy, because it had not been taken up to a considerable extent by the engineering societies. This is still true to-day and the object of this address is to

convince the members of this section and of our engineering societies of the importance of establishing aeronautical laboratories and courses of instruction in aerial engineering in America, in order to keep pace with their rapid development in Europe. The fundamental researches of our late associates, Langley, the physicist, and Chanute, the engineer, which first demonstrated the principles of dynamic flight, should be an incentive to further scientific work in this country towards its perfection.

A. LAWRENCE ROTCH

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THE INDEPENDENCE OF THE CULTURE OF THE AMERICAN INDIAN¹

IF one considers for a moment a map of the world, the two American continents are seen to possess one obvious characteristic in which the other great land masses do not share—isolation. From the time of the discovery America has been known as the new world, and indeed the name seems well deserved. Europe, Africa and Asia together with Australia and most of the islands of the Pacific form a closely connected and nearly continuous area. Within its limits races have come and gone, civilizations and cultures have risen and passed away, but each has been to some extent directly or indirectly influenced by others, and strong cultures have made their effects felt, albeit but faintly sometimes, to the furthest limits of this old world. A Mongol chieftain once made all Europe tremble; the conquests of a Chinese king perhaps decreed the age-long wanderings of the Polynesians; and the visions of an Arabian epileptic were the cause of movements that have overthrown empires and profoundly influenced the life of men from

¹ Address of the vice-president and chairman of Section H, Washington, 1911.

the northern rim of Europe to the edge of the South African deserts, and from the Pillars of Hercules to the Spice Islands of the east.

To understand and analyze, therefore, the culture of any given people or portion of the old world, the possible far-reaching effects of other cultures even although remote, must be borne in mind. In this it would seem, however, that America might be excepted. As far back at least as history or tradition goes it has stood alone, touching that other and older world only in the frozen north, and when, at the time of the discovery, Spanish, French and English broke down its barriers of isolation, it was to reveal peoples and cultures which for centuries and perhaps millenniums had been developing their own civilizations apparently untouched, neither influencing nor being influenced by those of the old world.

Yet in spite of the apparent isolation in which the people of America lived, no sooner were they known than various general similarities between them and peoples of the old world were observed, and theory after theory was brought forward attempting to derive them or their culture *en bloc* from elsewhere. Some, mostly of the earlier period, looked to the Semites and the Lost Ten Tribes, others to China and a party of Buddhist monks; others still to the islands of the South Seas or to Egypt and the fabled Atlantis. All such theories, however, it need hardly be said, belong to the period before the present in which more accurate and abundant observation and careful scientific method are employed. In spite of the many such theories exploited, the majority of students refused to accept the conclusions, many indeed going to the opposite extreme. They admitted that the various cultures which, as a result of the activity of investigators, had been

gradually outlined in the two Americas had unquestionably influenced one another, but they felt that although all American cultures might thus be in some degree interrelated, they had had no connection with any of the cultures of the old world. The similarities observed were thought to be coincidences due to the effects of similar environment and to the fundamental unity of the human mind. In short, so far as the history of culture was concerned, the new and old worlds formed two closed circles, tangent but not intersecting, within each of which different cultures had modified each other, but between which little or no interaction had taken place since human culture had attained to any real differentiation.

As our knowledge of different cultures both in America and elsewhere has come to be more detailed and their historical relations have become more and more apparent; as the methods of investigation have grown more exact and the criteria of relationship become more defined, the feeling has grown that after all, perhaps, the similarities between old and new world cultures might have a deeper meaning.

I may be permitted perhaps at this point to outline very briefly some of the methods and what seem to me to be some of the most reliable criteria of this so-called historical as opposed to the evolutionary school of anthropology. Such statements must indeed be trite, but will make clearer perhaps my argument further on. In essence the method depends upon the realization of the complexity of culture, that that of any given people is probably made up of elements derived from many sources, and that analysis must therefore precede a clear understanding. The analysis completed, the separate elements must be traced step by step and from tribe to tribe to determine their distribution. This

necessarily involves much careful consideration of apparently insignificant details, close comparison of archeological material with modern forms, the sifting and weighing of historical traditions, and the searching analysis of dialectic and archaic forms of speech. If as a result of such study, similarities are found to exist between different tribes or peoples, this is regarded as evidence of a real historic relationship; either one tribe has borrowed directly or indirectly from the other, or both have felt the influence from a common source.

But in drawing such conclusions we must proceed with caution, and constantly test our conclusions by reference to certain general principles. Perhaps the most obvious of these is the possibility or probability of such relationship on geographic or historical grounds. Thus resemblances between one tribe in South Africa and another in Chile would afford little basis for assuming relationship in their cultures, as from their very wide separation and known history, no reasonable ground exists for assuming any possible connection. On the other hand, similarities between the people on a remote island in eastern Polynesia and others in Assam or southern China may be significant, as there exists a possible route by which cultural influences or even migrations might have taken place, and there is historical evidence of movements of population on a tremendous scale in just this direction.

Another factor of importance is that of continuity of distribution. If striking similarities are observed between two widely separated peoples and no trace appears, either among the living peoples intervening, or from archeological evidence, of any connecting links, and there is no evidence of migrations, we must be cautious in assuming any genetic or historical relationship, and adopt at least as a work-

ing hypothesis that the similarities are due perhaps to convergent evolution, and that the two phenomena are in origin independent. A third point must also be considered in this connection. In tracing cultural influences and relationships, especially over wide areas, it is not to be expected that the implement, custom or belief will remain throughout precisely the same. As we pass from tribe to tribe and from region to region modifications are almost certain to be made, either in accordance with the various tribal or national characteristics and inherited tendencies, or as a result of the varying environment under which the people live; the implement will vary as a result of new uses and materials, the custom or belief will change with the different habit of thought and attitude toward the world of different tribes.

Of great importance again in drawing inferences from the observed similarity between implements or customs in different areas is the character and relative complexity of the things between which the similarity exists. Thus that two widely separated peoples both make use of a simple dug-out canoe is no necessary indication of historical or genetic relationship between them, as this is one of the simplest forms of canoe possible, and one which any two peoples making use of wood as a material must almost inevitably hit upon. If, on the other hand, both peoples make use of a canoe of unusual shape or one which shows some peculiar technical features in its construction or ornamentation, then the possibility or probability of relationship between the two peoples is established and should the peculiarity moreover be known only among these two peoples the evidence would become all the stronger. Further, if the peculiarities are in one case dependent on and in close relation to the environment or necessitated by

it, and in the other they show no such relation or are present only as useless or even detrimental features, the probability that the latter has in some way been derived from the former becomes great. The validity of the evidence for historical or genetic relationship thus is directly proportional to the unusualness or complexity of the things compared, features of very wide distribution or of very simple character being almost worthless for purposes of argument.

Lastly, if an attempt is made not merely to show relationship between single implements, customs or beliefs among different peoples, but to demonstrate a similar relation for an entire group of cultural elements, consideration should be given both to the question of the relative permanence and resistance to change of the different elements separately, and to the relative importance in the respective areas of the group of elements on whose similarities the claim for general cultural relationship is based.

The historical method in anthropological investigation, then, if it is to lead to trustworthy results, requires on the part of the student not only most careful and minute investigation and comparison of the facts themselves, but also the constant consideration of these in the light of their relation in time and space, their continuity, their modifications, their individual character and their relationship to the sum total of the culture of the respective peoples. That enthusiastic adherents of or converts to this historical as opposed to the evolutionary school should be led away by their enthusiasm and in so doing neglect to give due weight to these considerations is natural. It is also natural that the conclusions so arrived at should often be striking and almost revolutionary. But although the results may not receive gen-

eral acceptance, and although the theories may even bear upon their face their own refutation, still they may serve a useful purpose. On the one hand they may exemplify the dangers to which the followers of the historical method are exposed, and on the other they may often direct attention to a group of facts whose significance has been overlooked.

Such an over-enthusiastic application of the historical method as regards the question of the independence of the culture of the American Indian is exemplified to my mind in the theory recently advanced of the real and fundamental relationship of American and Melanesian cultures; I refer to that put forward by Dr. Graebner in his "Die melanesischen Bogenkultur und Verwandtes." The conclusions reached by the author of this most striking and painstaking study are, it seems to me, of value in demonstrating both the strength and the weakness of the method. For the ethnology of Melanesia, Polynesia, Micronesia, Indonesia and Australia, together with the adjacent parts of south-eastern Asia, Dr. Graebner's work is, I believe, in large measure valuable. It is where, abandoning the comparatively firm ground of Oceanic ethnology in which he is at home, he looks further afield, and finds in America (as indeed also in Asia, Africa and Europe) the evidences of a specific Melanesian culture, that I believe we must hesitate to follow him, and subject his facts and conclusions to careful scrutiny. General principles may often best be illustrated by concrete examples, and it is therefore with the idea of exemplifying some of the principles previously laid down, and not in any spirit of unfriendly criticism, that I propose to analyze and examine that portion of the theory of the Melanesian bow-culture which relates to America.

The theory in general may be summed up as follows. By a detailed analysis of the rather bewildering culture complexes of the closely interrelated peoples of Oceania, the conclusion is reached that a number of distinct cultures may be recognized, each marked by a coherent group of characteristic implements, usages, forms of social organization and beliefs; that these several cultures have spread successively over the region in question, and by their varied intermixture and superposition have produced the great complexity we find to-day. The various elements which go to make up the different cultures are regarded as so intimately interrelated and combined as to be practically inseparable, and as a particular combination to have had a definite origin in time and space. The occurrence of any considerable number of the separate elements of such a group among any given tribe or people is considered as sufficient evidence of the existence of the whole culture complex as an integral and historical feature in its development.

Of the various cultures so outlined and traced throughout Oceania, that of the so-called Melanesian bow-culture is taken up in most detail. The distinguishing characteristics of this culture are described as the self-bow of flat cross-section, arrows with fore-shafts, pile-dwellings, coiled pottery, twilled basketry, spoons, the hammock, paddles with handles at right angles to the shaft, bamboo combs, suspension bridges, the use of betel and tobacco and the pipe, hour-glass drums, communal dwellings, head-hunting and associated skull-cults, and the use of the squatting human figure and the spiral in art and design. Associated always closely with this culture is the two-class matriarchal culture, whose distinguishing features are in part the rectangular house with gable-roof,

plank-canoe, secret societies, masked dances and ancestral cults. Dismissing for the purposes of this enquiry the validity of these groups, and the correctness of the conclusions drawn in regard to their distribution in the Oceanic area, let us very briefly consider the evidence brought forward to prove their presence as fundamental and integral parts of American culture.

Beginning with North America, we find it stated that except for a few forms in the western United States which are of the type of the self-bow with flat cross-section, all other bows north of Mexico are either derivatives of the composite Asiatic or the reflexed, strengthened Arctic bow. Incidentally it may be noted that the statement could hardly have been more incorrect, as with few exceptions it is precisely in the west and on the Pacific coast that the strengthened bow is common, whereas the self-bow of rectangular cross-section is for the greater part of the eastern portion of the country the prevailing type. The presence, however, of the self-bow in North America is given as the first argument for the existence here of the Melanesian culture. It is to be noted, however, that this type of bow is almost the simplest and least elaborated form possible, the only simpler form being that where the stick has been left round in its natural state. Therefore the fact that this simple form of bow, which is in other parts of the world widely distributed, occurs both in America and in Melanesia does not constitute evidence of any historical relation between the two cultures.

For the Melanesian bow-culture in Melanesia, pile-dwellings are given as one of the most important characteristics, and their presence in America is signaled in Florida and on the northwest coast. So far as the first case is concerned, the rather

obvious relationship to similar types in northern South America, and the known Antillean and South American influences which have affected the Floridian peninsula and the adjacent parts of the Gulf shores, are wholly ignored; and to regard the occasional instances of the use of wooden blocks a few inches in height under the foundations of northwest coast houses as traces of pile-dwellings seems to strain the theory of historical relationship to the breaking-point. Pottery of coiled technique is referred to as another link connecting Melanesia and America, but here again little importance can be given to resemblances in such a simple factor, for the coil process is one of the most common methods employed in pottery-making by people the world over where the potter's wheel is not known. Twilled basketry is attributed to the Pueblo and Muskogean tribes, but its possible historical connection in the latter case at least, with Antillean and South American types, and its partial dependence on material, are both overlooked. The use of spoons which, contrary to the author's statements, is very widespread in North America, is a further striking example of an extremely simple implement, not whose peculiar form or decoration, but whose mere existence is regarded as evidence of cultural relation. Similarly without real value and in part erroneous as to fact, are the references to the paddle with handle at right angles to the shaft, and to communal dwellings. Since paddle shafts must either end in some form of cross-handle or be, like a broom-handle, without the cross-grip; and since dwellings must be either communal or not communal, there being no *tertium quid*, it hardly seems that the presence of one of the only two possible forms in each case should be regarded as evidence of cultural influence or identity.

On the basis of facts such as these which have been given as examples, and without further study or investigation of American cultures themselves, it is assumed that the Melanesian bow-culture may be traced as an essential factor in North American civilizations. In the brief discussion of the several instances given, it is apparent that not only does the writer show too slight an acquaintance with the facts relating to North America, but he violates in every case almost, the principle that the things compared and found similar if they are to prove real relationship, must in themselves possess some distinctive character, and not be simple and widely distributed. Dr. Graebner's theory, moreover, assumes that these elements of Melanesian culture reached America by way of northeastern Asia and Bering Strait, and while this is perhaps not wholly beyond the bounds of possibility geographically, it is contradicted by practically all historical and other evidence and probability. With few exceptions there is no evidence that cultural elements have passed from Asia eastward to America by way of Bering Straits, but on the contrary much evidence has in the last few years been brought forward to show that in fact the reverse has occurred, and that American influences have passed westward into Asia.

For North America, therefore, the case for the Melanesian bow-culture seems extremely weak, and indeed Dr. Graebner himself admits that, as compared with South and Central America, his evidence is scanty. It is necessary thus to examine briefly the argument presented for the presence of this Melanesian culture in the southern continent. At the very outset one is, to say the least, surprised to find in passing that solely from the occurrence of skin cloaks, round huts and coiled basketry, the Fuegians are regarded as repre-

sentatives of the early Australian culture. The willingness here shown to rest conclusions of far-reaching import on foundations of such extremely tenuous nature, can not fail, it seems to me, to lead us to look with some distrust at the author's other conclusions, and to accept them only with great caution.

Turning, however, to the Melanesian bow-culture, the area where this makes itself most strongly felt is said to be the northern and northwestern part of the continent. Here the self-bow of flat cross-section is the prevailing type; here in Guiana, Venezuela and Colombia the pile-dwelling is found; and here pottery (simply as such) is said to reach its highest development. In respect to the latter, a further instance is given of the author's incomplete acquaintance with the field with which he is dealing, in that the distribution given for pottery as "south as far as the Gran Chaco" wholly ignores the well-known fact of its extension to central Chile and far into Patagonia. Simple twilled basketry which is well-nigh universal throughout the northern two thirds of the continent is again brought forward as evidence of Melanesian influence, as is the use of tobacco and the pipe, the hammock and the paddle with cross-handle. Other elements noted are communal houses, head-hunting and skull-cults, and the use of the squatting human figure and the spiral in art. Associated with the Melanesian bow-culture in Melanesia itself is the so-called two-class matriarchal culture, and elements belonging to it, in the form of masked dances, knobbed clubs, plank canoes, pan-pipes and signal-drums are found also in South America. The fact that the chief center for all these elements of Melanesian culture lies in the northern and northwestern part of the continent suggests, says Dr. Graebner, their intrusion from Cen-

tral America and Mexico, where indeed he proceeds to show their presence.

In respect to most of the evidence thus brought forward for South and Central America, the same criticisms may be made as in the case of North America, and in many instances with added force. Here, as there, the mutual relations of the various cultures within the area are largely overlooked, and such well-established facts as that of the northward dispersal and migrations of the Carib and Tupi tribes are completely ignored. The propriety also of assuming that a feature so characteristic and widely distributed in South and Central America as the hammock has been introduced there from Melanesia where its occurrence is, on the contrary, extremely rare, seems rather questionable.

One of the strongest arguments against the validity of the Melanesian bow-culture theory as outlined by Dr. Graebner is, however, furnished curiously by the author himself, in the very abundance of the evidence and the closeness of the similarities which he claims for South America. The essence of the theory is that this Melanesian culture has, as a coordinated and intimately connected group of elements, been transmitted as a unit to the southern continent by way of eastern and north-eastern Asia, Bering Straits and North America. Now as the theory has not the temerity to assert the actual migration of Melanesian peoples from Melanesia through Asia and North America to the southern continent, it follows that the spread of the culture-complex must have been in the nature of a slow transmission from tribe to tribe, each in turn receiving the various elements, and incorporating them into the fundamental structure of its culture, before transmitting them to the next. That any such heterogeneous and not inherently related group of cultural

elements could survive unchanged transmission through scores of different tribes belonging to several distinct races; passing through the whole gamut of varied environments from the tropics to the Arctic circle and back again to the tropics; such transmission lasting necessarily over a period which must be reckoned in centuries or thousands of years; this is an assumption which is not merely beyond reasonable probability but is contradicted by almost all historical and ethnological evidence. It is to deny absolutely the well demonstrated fact that cultural elements when borrowed are subject to far-reaching and often fundamental modifications in accordance with the peculiar psychological characteristics of the borrowers and the environment in which they live; it is to assume that not even in the case of such absolutely elementary and natural things as the use of the skins of animals as protection against the weather, or of a spoon or a communal dwelling, could these have been developed independently and without historical relation; it is, in spite of Dr. Graebner's disclaimer, to throw aside the hard-learned lessons of the past two or three decades derived from the study of mythology, and to revert to the standards of a previous generation, and assume that similarities, whatever their nature and wherever they may be found, can only be explained as due to a common origin.

If then we must, as I believe, regard the theory proposed by Dr. Graebner of the presence of a Melanesian bow-culture in America as in no sense demonstrated, as fundamentally false in method and as exemplifying the most extreme position in the revolt against the theories of independent development, it does not follow that it must be barren of results. Indeed, its value lies, it seems to me, in the fact that it calls serious attention to the existence of

a really remarkable series of parallelisms between certain elements of American and Oceanic cultures, some of the more important of which, however, to my mind, the theory as proposed fails to note. That such parallels existed has for years been known, but hitherto little systematic attempt has been made to gather or explain them. The obvious suggestion has of course been made that they were the result of culture contacts along the Pacific Coast, of Oceanic with American peoples, but beyond this, little has been done. In part this has no doubt been due to the fact that most investigators have felt that our knowledge, particularly in regard to South America and much of Oceania itself, was still too incomplete to make a detailed study of the question profitable. Although I share in this feeling, I may perhaps be permitted in closing to point out a few of the facts which seem to me of special significance, and to urge the need of very thorough investigation of the whole field.

To my mind the most striking and for the purposes of tracing cultural relations, perhaps most important elements in common between the Oceanic area and America are, the true plank canoe, the use of a masticatory with lime, head-hunting and associated skull-cults, the blow-gun, throwing-stick, the hammock and perhaps the institution of the men's-house and certain peculiar masked dances and forms of masks in use in Papuan Melanesia and in America only in parts of Brazil. Of these the first three are either wholly confined to or reach their highest development on the Pacific coasts of both American continents, and the last three (with the exception perhaps of the men's-house) together with the third and fourth are confined to northwestern and northern South America and the immediately adjacent parts of Central America, with, in

the case of the blow-gun, such parts of North America as have been influenced by Carib and Arawak cultures. Compared with the self-bow, the use of coiled pottery, twilled basketry, the spoon, paddle with cross-handle and the communal dwellings of the Melanesian bow-culture, these are for the most part far from being simple affairs, and occur, moreover, with few exceptions, only in America and Oceania together with the adjacent parts of southern Asia. Six at least of the elements (the plank canoe, use of a masticatory with lime, head-hunting and skull-cults, blow-gun, men's-house and peculiar form of mask and masked dances) may be said to be in varying degrees exotic in American culture, in that their distribution is limited and that they are in contrast to the usual and prevailing American types. Four at least (the plank canoe, use of a masticatory with lime, head-hunting and skull-cults and the institution of the men's-house) are on the other hand of very wide and continuous distribution in Melanesia, Indonesia and southeastern Asia. To this list of cultural coincidences may be added among others the curious and ingenious process of polychrome dyeing known in Indonesia as *Ikat*, and which occurs except for the region of Indonesia and adjacent southeastern Asia nowhere else, so far as known, but in Peru.

In any attempt at explanation of these facts, the strong concentration of the elements in America on the Pacific coast and in the western portions of the two continents, and their almost total absence in the eastern parts, seems of considerable importance. In this connection the as yet only fragmentary evidences of early migrations in South America from the Pacific coast eastward into the Orinoco-Amazon area must not be lost sight of. From this distribution, the explanation

which most readily suggests itself is of course the old one of direct contact along the Pacific coast. Elements of material culture might well be adopted thus as a result of the chance drifting ashore of a canoe with a handful of survivors, or even without these, from the region to the west; and the sporadic character of the occurrence of such features as the plank canoe, known only in Chile and on the coast of southern California, might thus naturally be explained. The difficulty, however, in attempting to explain the whole problem in this way lies in the fact that it is not with the migratory and sea-roving Polynesians that the cultural coincidences are strongest, but rather with the Papuan (as opposed to the Melanesian) tribes of New Guinea and with the older cultures of Indonesia. / The Papuan tribes are not, so far as we know, a markedly seafaring people, and so far no evidence of their actual presence east of the 180° meridian has come to light. The people of Indonesia also, among whom the resemblances are found, although far more capable navigators, have nevertheless left no certain traces of their presence to the eastward of the Moluccas and the western end of New Guinea. Moreover, the Polynesians could hardly have served as the intermediaries through whom these elements were transmitted, as they themselves show, except for the plank canoe, little trace of them. Unless, then, strong evidence should come to light of an earlier more easterly extension of Papuan and Indonesian peoples, or some explanation be offered for the almost complete absence of the features in question among the Polynesians, the solution of the problem by supposing a direct transmission across the Pacific seems barred by the facts of geographic position and history. A similar result seems also to appear if the attempt is made to trace the elements

by way of the Asiatic and North American littoral. Thus in the present state of our knowledge, neither by way of the long, circuitous route through Asia, Bering Straits and Alaska, nor by the more direct route across the Pacific can we satisfactorily account for the series of striking coincidences in culture between western America and particularly western South America, and Oceania with the neighboring parts of southeastern Asia.

Such a negative conclusion or verdict of "not proven" is generally most unsatisfactory. In the present case, the coincidences are so striking, in both character and distribution, that we are almost forced to believe in some sort of historical connection. But I believe we should for the present continue to be cautious. The possibility of independent development must not be denied even in the case of these quite peculiar features, nor need the fact that only a portion of the American peoples showing coincidences live in similar tropical or semi-tropical environment be regarded as a serious objection to this hypothesis.

To revert again to my title, I believe that in the present state of our information, we must still regard American Indian culture as in all its essentials and in most of its details, as of independent growth, uninfluenced by the cultures of the old world, and recognize that its geographical isolation has in fact proved to be a cultural isolation also, and that/ although certain curious coincidences undoubtedly exist with parts of Oceania and southeastern Asia, no historical relationship between the cultures of the two widely separated regions can as yet be said to have been established. That with increasing knowledge historical relations may indeed be shown seems to me wholly possible, but its demonstration must rest

upon that fuller knowledge of fact and of the historic sequence of cultures in the respective areas, and on the practise of the general principles of evidence some of which I have here attempted to set forth and illustrate.

Anthropologists are at present, as was recently pointed out by Dr. Rivers in his address as vice-president of the section in the British Association, in the unfortunate condition of not agreeing on fundamental questions of method. We have, it is hoped, left behind us the period of vague and futile theorizing without facts or with too few facts, but there are still many who believe that evolution is the master-key which will unlock all doors, and that by the amassing of more or less heterogeneous and unrelated facts from all over the world a continuous development through definite stages of culture may everywhere be shown. The partizans of independent development based on the theory of the psychological unity of the human mind, are set over against those who believe in the complexity of cultures, and the possibility that by analysis and comparison their historic relationships may be determined, and who would explain similarities in culture between widely separated peoples on this basis or on that of convergent evolution. Here in America we have come to feel, I think, more perhaps than elsewhere, that no one of these theories is a panacea. As a result of the experience of the last decade or so in attempting to outline and define the several culture areas in this continent, we are beginning to realize that these several points of view may all and at the same time be true, and to admit that in a given culture, whereas some elements are undoubtedly the outcome of contact or transmission, others may be the result of evolutionary development, and dependent on the general uni-

formity of reaction to similar stimuli among mankind as a whole; and we are prepared, I trust, to agree that if fact and theory do not conform, it is the latter for which the Procrustean bed should be reserved.

It is in this spirit, then, of insistence on abundant fact and its careful interpretation, without prejudice and unencumbered with rigid theories which will admit of no compromise, that I believe we should approach the question of the independence of American culture; a question which has its greatest interest quite naturally for us in America, but which for anthropology as a whole is also of great and far-reaching importance.

ROLAND B. DIXON

*THE PERCENTAGE OF WOMEN TEACHERS
IN STATE COLLEGES AND
UNIVERSITIES¹*

THE average per cent. of women teachers for all the state colleges and universities is 9+. The average for the schools west of the Mississippi is 13+ per cent., while for the schools east of the Mississippi it is 6+ per cent.

Eleven schools,² which were selected at random, have 149 women teachers. Of these 149, 10+ per cent. are full professors, 5+ per cent. are associate professors, 10+ per cent. are assistant professors and 73+ per cent. instructors.

As to the subjects these 149 women teach, the distribution is: professors, home econom-

¹These figures base upon "Statistics of State Universities and other Institutions of Higher Education Partially Supported by the State," for the year ended June, 1910 (Washington, Government Printing Office), and catalogues of eleven institutions for the year 1910.

²The eleven schools are: University of Arizona, Iowa State College, Miami University, University of Montana, University of New Mexico, North Dakota Agricultural College, Ohio University, University of Oklahoma, University of South Dakota, University of Utah, University of Wyoming.

Name of Institution	Professors and Instructors		Per Cent. of Women Teachers	Name of Institution	Professors and Instructors		Per Cent. of Women Teachers
	Women	Total			Women	Total	
Alabama Polytechnic Institute.....	0	65	0	North Dakota Agricultural Col- lege.....	10	62	16+
University of Alabama.....	0	54	0	State University and School of Mines (N. Dak.).....	12	77	15+
University of Arizona.....	11	42	26+	Ohio University.....	24	58	41+
University of Arkansas.....	19	133	14+	Ohio State University.....	14	214	06+
University of California.....	6	297	02+	Miami University (Ohio).....	8	53	15+
University of Colorado.....	14	141	09+	University of Oklahoma.....	11	63	17+
State Agricultural College (Colo.)	11	67	16+	Oklahoma Agricultural and Me- chanical College.....	12	63	17+
Colorado School of Mines.....	0	20	0	Oregon State Agricultural Col- lege.....	19	89	21+
Connecticut Agricultural College..	5	24	20+	University of Oregon.....	8	102	07+
Delaware College.....	0	27	0	Pennsylvania State College.....	10	149	06+
University of Florida.....	0	22	0	Rhode Island State College.....	5	27	14+
Florida State College for Women.	14	25	56	South Carolina Military Academy	0	13	0
University of Georgia.....	0	48	0	Clemson Agricultural College (S. C.).....	0	48	0
Georgia School of Technology.....	0	48	0	University of South Carolina.....	3	32	09+
North Georgia Agricultural Col- lege.....	2	15	13+	South Dakota Agricultural College	7	52	13+
University of Idaho.....	9	51	17+	South Dakota State School of Mines	0	16	0
University of Illinois.....	53	565	09+	University of South Dakota.....	12	46	26+
Indiana University.....	10	179	05+	University of Tennessee.....	9	143	06+
Purdue University (Ind.).....	9	156	05+	University of Texas.....	6	103	05+
Iowa State College of Agriculture and Mechanic Arts.....	33	142	23+	Agricultural and Mechanica Col- lege of Texas.....	0	52	0
State University of Iowa.....	14	165	08+	Agricultural College of Utah.....	11	58	18+
University of Kansas.....	28	187	14+	University of Utah.....	16	74	21+
Kansas State Agricultural College	44	157	28+	University of Vermont and Agri- cultural College.....	1	89	01+
State University (Ky.).....	4	67	05+	Virginia Polytechnic Institute.....	0	64	0
Louisiana State University and Agricultural and Mechanical College.....	3	59	05+	University of Virginia.....	0	76	0
University of Maine.....	2	77	02+	Virginia Military.....	0	22	0
Maryland Agricultural College.....	0	29	0	College of William and Mary (Va.).....	0	20	0
Massachusetts Agricultural College	0	41	0	State College of Washington.....	10	77	12+
Massachusetts Institute of Tech- nology.....	1	223	004+	University of Washington.....	4	103	03+
University of Michigan.....	4	317	01+	West Virginia University.....	15	91	16+
Michigan State Agricultural Col- lege.....	21	104	20+	University of Wisconsin.....	38	459	08+
Michigan College of Mines.....	0	30	0	University of Wyoming.....	14	43	22+
University of Minnesota.....	9	193	04				
Mississippi Agricultural and Me- chanical College.....	0	53	0				
University of Mississippi.....	0	32	0				
University of Missouri.....	12	162	07				
Montana College of Agriculture and Mechanic Arts.....	10	45	22+				
Montana State School of Mines...	0	7	0				
University of Montana.....	5	24	20+				
University of Nebraska.....	42	261	16+				
University of Nevada.....	9	40	22+				
New Hampshire College of Agri- culture and Mechanic Arts.....	0	35	0				
Rutgers College (N. J.).....	7	56	12+				
New Mexico College of Agri- culture and Mechanic Arts.....	6	33	18+				
University of New Mexico.....	5	16	30+				
New Mexico School of Mines.....	0	8	0				
Cornell University (N. Y.).....	16	636	02				
University of North Carolina.....	0	99	0				
North Carolina College of Agri- culture and Mechanic Arts.....	0	45	0				

³ From 1909 report.

ics, 3; English, 2; modern language, 2; history and Spanish, 1; philosophy, 1; political science, 1; school training, 2; fine arts, 1; physical education and elocution, 1, and clinical medicine, 1.

Associate professors: English, 2; chemistry, 2; domestic science, 1; mathematics (and dean), 1; commercial, 1; library science, 1.

Assistant professors: English, 7; domestic economy, 3; Latin and Greek, 2; philosophy, 1; mathematics, 1; public speaking, 1; history, 1.

Instructors: music, 20; modern language, 14; English, 13; natural science, 8; school training, 7; history, 8; physical education, 6;

art, 6; commercial branches, 5; mathematics, 4; domestic science, 5; public speaking, 3; ancient languages, 2; mechanical drawing, 2; kindergarten, 2; Latin and English, 2; elocution and physical culture, 1; pediatrics, 1.

The groups for which women qualify are therefore, in order of frequency: English, music, modern language, domestic science and home economics. In natural science and mathematics they do not often rise above the rank of instructor.

The high per cent. of women teachers west of the Mississippi may be explained by saying that the west is less conservative than the east; that there are more coeducational institutions in the west; that the western schools were founded after women began to compete for college positions, while the majority of eastern schools were founded before this time. Lack of ample funds may also at times have dictated the choice of cheaper service.

The number and per cent. of women in the various schools is given on page 56.

C. H. HANDSCHIN

SCIENTIFIC NOTES AND NEWS

MR. ARTHUR D. LITTLE, of Boston, was elected president of the American Chemical Society at the Washington meeting.

PROFESSOR E. G. CONKLIN, of Princeton University, has been elected president of the American Society of Naturalists.

PROFESSOR ROSS G. HARRISON, of Yale University, was elected for the coming two years president of the American Association of Anatomists at the recent Princeton meeting.

DR. S. J. MELTZER, of the Rockefeller Institute for Medical Research, has been reelected president of the American Physiological Society.

THE Academy of Natural Sciences of Philadelphia has awarded the Hayden Medal in gold for distinguished work in geology to Professor John C. Branner, of Leland Stanford Jr. University.

PRESIDENT TAFT has nominated Dr. Rupert Blue, of South Carolina, as surgeon general of the public health and marine hospital service,

succeeding the late Dr. Walter Wyman. President Taft gave notice that hereafter the term of service of the surgeon general of the public health service shall be limited to four years.

M. HENRI BERGSON, professor of philosophy at the Collège de France, has been appointed visiting French professor of Columbia University for the year 1913. M. Bergson has also been appointed Gifford lecturer at Edinburgh.

THE organ of the Japan Peace Society gives an account of the visit of Dr. David Starr Jordan, president of Stanford University, in August, September and October, of last year, undertaken under the auspices of the Japan and American Peace Societies. Dr. Jordan gave a large number of addresses, mainly on peace and arbitration, at Tokyo, Yokohama, Sendai, Nagoya, Okayama and Osaka. At Tokyo between September 13 and 18, Dr. Jordan gave as many as ten addresses, not including after-dinner speeches.

DR. W. A. CANNON, of the Desert Laboratory, is acting director of the Department of Botanical Research of the Carnegie Institution during the absence of Dr. D. T. MacDougal, who is traveling and studying desert conditions in Upper Egypt and portions of the Soudan.

MR. MYRON L. FULLER, for many years a geologist on the United States Geological Survey and chief of the Eastern Section of the Division of Hydrology from 1903-07, has formed an association with Mr. Frederick G. Clapp, also formerly of the Geological Survey, to act as consulting experts in all branches of geological engineering, especially in water supplies, bridge and dam foundations, ore deposits, oil and gas.

THE *Strand Magazine* has obtained a vote to determine the ten greatest men now living. The speaker of the house of commons drew up a list of eighteen men and other distinguished men voted for names by reduction and substitution. The final list in the order of the number of votes was: Edison, Kipling, Roosevelt, Marconi, Lister, Chamberlain, Roberts, William II., Metchnikoff.

DR. A. D. IMMS, professor of biology, University of Allahabad, has been appointed forest zoologist to the government of India.

A REUTER'S telegram states that Dr. Kinghorn, who is at present in Northwestern Rhodesia, has transmitted the *Trypanosoma rhodesiense* by means of *Glossina morsitans*.

At a meeting of the Pellagra Investigation Committee on December 12, in London, Dr. Louis Sambon and Dr. A. J. Chalmers gave an account of the work of the Field Commission on Pellagra, from which they have just returned. The commission visited Hungary, Roumania, the Austrian Tyrol, North Italy and Spain, examining the districts in the several countries where pellagra prevails.

DR. WILLIS RODNEY WHITNEY, director of the research laboratory of the General Electric Company, lectured before the Middletown Scientific Association on January 9, his subject being "Research Laboratory Notes."

PROFESSOR G. F. SWAIN, of Harvard University, has returned to Cambridge from a trip to the middle west, where he gave the annual Sigma Xi lectures at the University of Kansas, the University of Missouri and Washington University.

At the recent meeting of the American Physiological Society in Baltimore Dr. W. B. Cannon, of the Harvard Medical School, delivered a memorial address on the late Professor Henry Pickering Bowditch.

MAJOR CLARENCE EDWARD DUTTON, U.S.A., retired, distinguished for his services in the civil war and later in the ordnance corps of the army and eminent for his contributions on volcanoes and earthquakes, died on January 4 at his home in Englewood, N. J., aged seventy years.

DR. ARTHUR V. MEIGS, of the third generation of a family of noted physicians and surgeons, and widely known as a physician and author of medical works, died on December 31 at his home in Philadelphia, at the age of sixty-one years.

MR. GEORGE R. M. MURRAY, F.R.S., for many years on the staff of the department of

botany of the British Museum, known for his contributions on fungæ and algæ, died on December 15, aged fifty-three years.

M. PAUL TOPINARD, the distinguished French anthropologist, has died at the age of eighty-one years.

M. RADAU, member of the astronomical section of the Paris Academy of Sciences, has died at the age of seventy-seven years.

PROFESSOR ODILON MARC LANNELONGUE, the celebrated pathologist and surgeon, died in Paris on December 22, at the age of sixty-one years. At the time of his death he was president of the Paris Academy of Medicine and a member of the French parliament.

THE third annual meeting of the Paleontological Society was held at the new National Museum building, December 28-30, 1911, with 59 of its 136 members present. The results of the election of officers for the society for 1912 were as follows:

President—David White, Washington, D. C.

First Vice-president—J. C. Merriam, Berkeley, Cal.

Second Vice-president—Rudolf Ruedemann, Albany, N. Y.

Third Vice-president—E. W. Berry, Baltimore, Md.

Secretary—R. S. Bassler, Washington, D. C.

Treasurer—Richard S. Lull, New Haven, Conn.

Editor—Charles R. Eastman, Cambridge, Mass.

THE American Society for Pharmacology and Experimental Therapeutics held its third annual meeting in the Pharmacological Laboratory of the Johns Hopkins University, December 27 and 28. Thirty-one papers and demonstrations were presented and discussed. On the afternoon of the 27th there was a joint meeting with the American Physiological Society. Dr. J. J. Abel was reelected president and Dr. John Auer was elected secretary. The following new members were elected: T. S. Githens, of the Rockefeller Institute; Y. Henderson, of the Yale Medical School; D. R. Hooker, of the Johns Hopkins Medical School; L. Nelson, of the Harvard Medical School; J. D. Pilcher, of the Western Reserve University Medical School, and G. B. Roth, of the University of Michigan.

THE seventeenth meeting of the Association of Teachers of Mathematics for the Middle States and Maryland was held at Columbia University on Saturday morning and afternoon, December 2. The morning program consisted of the following papers: (1) "An Allegation applied to the Calculations of Analytical and Industrial Chemistry," by W. A. Ballou, Pratt Institute; (2) "What Subjects in the High School Mathematics are of Greatest Use in Preparation for Analytical Geometry and Calculus in College," by W. J. Babb, of the University of Pennsylvania, and A. S. Gale, of the University of Rochester. In the afternoon the program consisted of (1) "Educational Values in Mathematical Instruction," by H. E. Hanks, of Columbia University; (2) "Provisional Report of the National Geometry Committee of Fifteen," by Howard F. Hart, of the Montclair High School. The following officers were elected:

President—I. J. Schwartz, University of Pennsylvania.

Vice-president—A. E. King, Erasmus Hall High School, Brooklyn.

Secretary—H. F. Hart, Montclair High School, Montclair, N. J.

Treasurer—Susan C. Lodge, Philadelphia Collegiate Institute, Philadelphia.

Council Members—A. S. Gale, University of Rochester, Rochester; J. T. Rowe, Wm. Penn High School, Philadelphia; Harry English, Division of High School Mathematics, Washington.

THE first annual dinner of the Edinburgh University Club of North America, was held on December 27, at the University Club in the City of New York. Professor Clarence Webster, Chicago, the president of the club, occupied the chair, and about sixty alumni of Edinburgh University were present. Congratulations upon the birth of the club were received from the chancellor of the university, the Right Hon. Arthur J. Balfour, M.P., from Principal Sir William Turner, K.C.B., from the last lord rector, Lord Haldane, of Cluan, from the university parliamentary representative Sir Robert Baunatayne Finlay, from Sir Alexander R. Simpson, Dr. George A. Gibson and others. The Hon. Joseph H. Choate, LL.D., Edin., discoursed eloquently

upon "Our Alma Mater"; the Right Rev. Frederick Bishop Courtney, upon "Scottish Character"; Professor Prince, Ottawa, Canadian Commissioner of Fisheries, upon "United States" and Sir James Grant, Ottawa, upon "Canada." The club bard, Mr. Robert Easton, charmed every one with his rendering of Scotch songs. Great enthusiasm prevailed. The first function of the club was a marked success. Graduates and undergraduates of the university are eligible for full membership of the club. Fellows and licentiates of the Royal Colleges and post-graduate students of Edinburgh University may, as associate members, attend the annual dinners. Any who are interested are invited to communicate with the secretary, Edinburgh University Club, 20 East Sixty-ninth St., New York City.

We learn from the *British Medical Journal* that on December 6 a dinner was given to welcome Professor Newstead on his return from the sleeping sickness expedition to Nyasaland and to wish godspeed to Dr. Harald Seidelin on his departure on a yellow fever expedition to Yucatan. Owing to having contracted a chill, Professor Newstead was unable to be present. Sir William H. Lever, who was in the chair, in proposing the toasts of the evening, remarked that the trustees of Sir Alfred Jones had intimated that they would come to the assistance of the school, and, in addition to better accommodation in Liverpool, it was proposed to establish a laboratory on the West Coast of Africa, where investigations into tropical diseases might be made on the spot. The government had given support to their movement, but he considered it was not adequate, and he echoed Sir Owen Phillips's opinion that it should grant to the London and Liverpool Schools £10,000 annually. If America had succeeded in making the Panama zone healthy, there was no reason why they should not, with adequate financial support, make West Africa sanitary.

A MEETING of the trustees of the Beit Memorial Fellowships for Medical Research was held on Tuesday, December 19, when ten fellows were elected. Each fellowship is of the

annual value of £250. The usual tenure is for three years, but the trustees have power in exceptional cases to grant an extension for one year.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JACOB H. SCHIFF has given \$100,000 to Cornell University to promote studies in German culture.

THE million dollar fund for the further endowment of the Medical School of Western Reserve University has been completed.

DE PAUW UNIVERSITY has just brought to a successful close the campaign to raise \$400,000 to meet the conditional gift of \$100,000 from the Rockefeller Educational Board. The subscriptions total a little more than \$440,000. This will make the productive endowment of the university something above \$1,000,000.

ON December 13 an anonymous gift of £30,000 was made to the University of London, to be devoted to the erection at University College of the buildings for the new school of architecture, resulting from the amalgamation of the architectural department of University College and King's College. Any balance is to be used for providing studios for the teaching of sculpture and the rearrangement of the school of fine art and for the department of applied statistics, including the laboratory of eugenics.

THE Supreme Court of Illinois, on the final day of its fall term, failed to hand down a decision in the case involving the validity of the appropriation made by the legislature for the Medical School of the University of Illinois.

FOLLOWING the custom of recent years, the United States government has sent officers of the army and navy to the Massachusetts Institute of Technology to receive instruction in electrical engineering. These are in addition to the graduates of the Naval Academy who are sent to take a course in naval architecture. This year the Naval Academy is represented by Ensign G. K. Calhoun, who was graduated from Annapolis in 1908. He has recently been stationed at the United States Naval

Observatory at Washington where he has done considerable original work in wireless telegraphy, ship propulsion, gyroscopic compasses and chronometers. The army is represented by Captain Edward Canfield, West Point, 1901, and First Lieutenant F. Q. C. Gardner, West Point, 1904. Both officers have been connected with the Coast Artillery Corps, Captain Canfield being stationed at Puget Sound and Lieutenant Gardner at Fortress Monroe. Both men will pursue a special course in electrical engineering.

THE council of the University of Paris has sanctioned a scheme for an exchange of students between the universities of Paris and London.

THE Veterinary School of Lyons, France, said to be the oldest in the world, will celebrate the hundred and fiftieth anniversary of its foundation next May.

DR. CLYDE A. DUNIWAY, of the University of Montana, has been informed by the Board of Control that he will not be reappointed as president of the university. It is understood that this action has been taken because President Duniway refused to appoint a local politician as dean of the law school of the university.

DISCUSSION AND CORRESPONDENCE

WHAT IS BIOLOGY AND WHAT IS A "BIOLOGICAL SURVEY"?

THE occasion for the present note is found in the recent publication of "A Biological Survey of Colorado."¹ Probably most students of plants and animals have long wished that the word "biology" had never been coined. It is so often misunderstood by the non-scientific person. In the days of the old taxonomy and of the former rigid morphology there were few people really interested in both plants and animals. With the advent of ecology, and more recently of genetics, botanists and zoologists have been brought together and

¹ Issued as "North American Fauna," No. 33, as a publication of the Bureau of Biological Survey, Washington, 1911. The author, Merritt Carey, is stated to be "Assistant Biologist, Biological Survey."

it has seemed that perhaps there might be, after all, such a subject as "biology."

But now when it seemed that the word "biology" might really have a meaning there is issued from Washington this report, which even at very first glance belies its title. The real nature of the publication is indicated in the "Letter of Transmittal" in which it is stated that

The report consists of three parts. The first characterizes the five life zones which traverse the state, defines their extent and limits and discusses their agricultural possibilities. The second consists of a complete list of the mammals of Colorado with brief notes on their habits, distribution and economic relations. The third is a list of the principal trees and shrubs of the state observed by the assistants of the biological survey during the progress of work in the state, with annotations as to their distribution and abundance.

Just why such an ambitious title as "A Biological Survey of Colorado" should be used for this report is nowhere stated and certainly is not apparent from internal evidence.

If this were the first study of the kind ever made in Colorado it would be a most excellent work. The material here presented, however new to the author, is very little of it new to science. Warren's "Mammals of Colorado," published in 1910, covers the mammals quite fully and numerous publications on ornithology and botany go far beyond the present report in most of the things mentioned in those branches. There are references to various publications on mammals and to one single botanical report, but apparently all the other information given by the author is from his own work. It is little short of marvelous that a young man with so little knowledge of the state, of its climate, its flora and its fauna has been able to prepare so good a report.

The discussion of life zones is conspicuous for that perfect independence of thought characteristic of those who know nothing of the writings and opinions of others. It would seem worth while, before writing about the native animals or plants of a state, to consult the published works of men of science resident in the state. Thus many laughable mistakes might be avoided.

It is a question worth considering whether the writer of "a biological survey" of any state would not do well to visit the museums within the state and make himself known to the naturalists who might help him in his work. The writer of "A Biological Survey of Colorado" according to his own account made his start from Boulder, but apparently did not take the trouble to visit the university there nor the museums in Denver, only 30 miles away.

From a reading of the report under consideration one would imagine that his was the first biological work ever undertaken in the state, save certain previous work on mammals, to which scant reference is made. Even if "a biological survey" means an account of one's own personal experiences in collecting mammals it would seem the part of candor to let the reader know that other men of science have at least looked upon the plants and animals of the region visited.

It is to be hoped that the next time the Bureau of Biological Survey at Washington authorizes the prosecution of "a biological survey" of any state, provision will be made to make the body of the report agree with the title. It would be interesting to know of naturalists generally whether they conceive "biology" to be synonymous with "mammalogy" and also to know whether an account of field trips made by one man is really "a biological survey" of a state.

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PHYSICAL LABORATORY INSTRUCTION

The article in the December 15 number of *SCIENCE*, p. 823, by G. W. Stewart on "An Opportunity for the Spirit of Research in Laboratory Instruction in Physics," seems to be a move in the right direction. One aid towards securing this spirit of research is to be found in dispensing with detailed instruction sheets, and with apparatus that is set up and in adjustment. The best way in which to give instructions is in the form of a lecture,

in which the underlying principles are explained, and the object of the experiment is clearly pointed out. In this way a student is permitted to approach the experiment in the same way in which the first person who did it approached it, *i. e.*, as a research problem.

The lecture system necessarily involves the use of some kind of grouping of the experiments. This last, however, is an advantage, as it permits running the laboratory and classroom work parallel to one another.

Another aid with the same object as above, is not to insist too strongly on precise measurements by elementary students. The elementary student is often frightened by the task of measuring a thing down to one one-hundredth of one per cent. with a strange piece of apparatus. Only after the student has acquired confidence in himself as an experimenter should great accuracy be insisted upon. However, from the very first the student should express the percentage of error of his observations. By accepting all work at first, with a percentage of error simply indicating poor experimental ability, the student is encouraged to try the experiment. This last also does away with the incentive to "doctor the results." On the other hand, the student dislikes to pass in an experiment with a larger percentage of error than that obtained by the best experimenter in the class, so that he tries his hardest to get a correct result.

The foregoing are simply aids to the spirit of research, the principal thing being the "attitude of the instructor" rather than any particular method.

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THE MEETINGS OF AFFILIATED SOCIETIES

TO THE EDITOR OF SCIENCE: I feel like seconding all that Professor Morse has said in a recent (December 22, 1911) number of SCIENCE in regard to the custom that has arisen among some of the "affiliated societies," especially the zoologists, of holding the winter-meeting at a different place from that in which the American Association meets.

As I stated before the zoologists at the recent meeting at Princeton, there was a very strong feeling expressed by a number of prominent zoologists at the Washington meeting against the present method of meeting at different places, especially when the meetings are at the same time.

I should like to see a general expression of opinion, through these columns, or otherwise, upon this subject, especially by those zoologists who are members of the American Society of Zoologists. Such an expression of opinion might serve, in some measure, as a guide to the committee that was appointed by the Society of Zoologists to look into the matter.

ALBERT M. REESE

QUOTATIONS

THE BRITISH INSURANCE ACT

"BUYING men's all right—the trouble is they won't stay bought." Such was the reflection of a disillusioned political boss. In the same way it is often easy enough to "do" men. The trouble is they won't stay "done." Mr. Lloyd George is finding that out in the case of the doctors. The members of the medical profession are notoriously bad men of business. They are very busy, and they find it impossible, unlike most other professionals, to divide their lives into water-tight compartments of work and leisure. They are harassed at all hours by calls upon their time and, still more, upon their mental energy. Hence they can attend very little to their professional interests. This fact made them and their leaders an easy prey to so astute and persistent a diplomatist as Mr. Lloyd George. Early in the game he saw that from the point of view of public agitation and public opposition to his measure, it was far more important to conciliate the friendly societies and prevent their rising in revolt than to make concessions to the doctors. Accordingly he "put his money on the societies," and merely put a little chloroform on a handkerchief in the case of the doctors, whispering to them at the same time that it would be all right when they woke up. The suggestion was that they would be

able to make any terms they liked with the local insurance committees when once these were formed. This simple but most successful artifice, and the curious belief entertained by the doctors up to the last moment that Mr. Lloyd George would never dare to pass his bill without having come to a clearer understanding with them that they would work his scheme, prevented the medical profession doing what they might have done, and ought to have done—that is, organize pressure upon members of Parliament and upon the House of Lords in order to prevent the bill passing till their claims had been properly recognized. Now, however, that the bill has actually passed, and the task of putting things right is multiplied a thousandfold in difficulty, the doctors are beginning to wake up and see the terrible position into which they have got themselves, or rather, as the rank and file would say, into which their leaders, inexperienced in political negotiation, have got them. They are at last beginning to understand the very simple rule of strategy—"if you allow yourself to be taken in detail, you are lost." Instead of the doctors being able to make good terms with the individual insurance committees, they are beginning to see that the only chance of their not being bullied into starvation rates by those committees is for the whole profession to hold resolutely together and not to allow themselves to be pounded up piecemeal. At the great meeting at the Queen's Hall on Tuesday night it was obvious that the medical profession is at last seriously alarmed. They realize that they have been "done," but they do not intend to stay "done." Unless we very much mistake the signs of the times, the medical profession mean to organize resistance to the act and to refuse to make any agreements under it, unless and until their just claims are recognized. And here we may interpose that if Mr. Lloyd George offers to negotiate with them, as we fully expect he will, they will, if they are wise, not be content for a second time with promises and general assurances. They must insist that whatever concessions are made shall be embodied in an amending act, to be passed as

soon as may be after Parliament reassembles, or, at any rate, before the date at which the measure comes into operation—i. e., July 1 next. They will be told, of course, that such a suggestion is absurd and that nothing can be done till Home Rule is out of the way. "If nothing else forbade it, Mr. Redmond would not," etc. The only answer to this is, "If you can not find time, you can not have our assistance in working your measure."

An even more important sign that the doctors are growing alive to the position of deadly peril in which their interests are placed under the act is to be found in the quasi-referendum which has been organized by a medical newspaper, *The Practitioner*. The journal in question sent out a voting paper to the 29,567 medical practitioners of Great Britain, asking them the following question:

Are you satisfied that the arrangements made for the profession with regard to the medical service now embodied in the National Insurance Bill would justify you in giving honest and adequate service to the insured?

The result of the poll was most remarkable. 20,712 replies have already been received, with the result that 20,149 doctors have answered "No"—that is, have declared that they are not satisfied that the arrangements of the Insurance act will justify them in giving adequate service to the insured. Only 352 out of the whole 29,000 have expressed themselves as satisfied, while 211 have asked questions—a fact which would seem to indicate that they are not satisfied. Very naturally *The Practitioner* realizes that it is no use to stop at eliciting the dissatisfaction of the profession. Accordingly it has now asked the doctors of Great Britain—Ireland is not affected—or, rather, those who are dissatisfied with the act, to give the following pledge:

Feeling that the present National Insurance Act is unjust to the medical profession, I hereby pledge my word not to accept any service whatsoever under it. I stipulate, however, that unless at least 23,000 members of my profession in Great Britain combine with me in this pledge, I am to be freed from it.

The pledge is very fairly as well as very ingeniously worded. A doctor whose livelihood depends upon his practise might well shrink from entering upon an obligation which he might find left him isolated. To say, however, that he is willing to run the risks of refusing work under the act if others will stand by him is a very different matter. And here we may remark that the number, 23,000, is not taken at haphazard. It is calculated that at the very least 8,000 doctors will be required to work the insurance scheme. Therefore if 23,000 of the medical men of the country agree to stand together in not working it, the act can not possibly be put into successful operation. The result of *The Practitioner's* second move will, we take it, not be announced before these pages have gone to press, but we shall be very much surprised if the second voting does not correspond with the first. If it does, and some 23,000 doctors are pledged not to take service under the act, the doctors will have done what, in our opinion, the Lords ought to have done: they will have secured a period of delay in which just and reasonable terms can be made with the profession as a whole, and any attempt to take the doctors in detail defeated.

Before we leave the subject we must point out one or two misapprehensions which have arisen, or are likely to arise, in the public mind in regard to the movement. In the first place the public must not suppose that the doctors are threatening to withhold medical advice from the poor or from the sick, the injured or the dying, until they have got their terms. Nothing in the nature of a refusal of their services is threatened or is contemplated by the doctors. They merely say that they will not enter into the special and peculiar contracts which they will be required to make under the act if they are to obtain its so-called benefits. The result will only be that medical attendance on the poor will go on exactly as it is going on at this moment. The poor and the artisans will be looked after by the doctors in the future just as they have been looked after by the doctors in the past and are being looked after now. There is not the slightest ground for the suggestion that the doctors are trying to ex-

tort terms by a strike or are doing anything which would disgrace the most humane and the most self-sacrificing of all the professions. As before, they will do what no other profession does: give an immense amount of gratuitous service, not because they like doing work without being paid any more than other men, but because it is their honorable tradition to relieve suffering first and consider the question of payment afterwards—to let the sick and the injured have medical aid gratis or for some derisory remuneration rather than that men and women should suffer when that suffering can be relieved. That noble attitude can, and will, be maintained perfectly well even if the doctors refrain from signing the unfair contracts which will be presented for their signature under the act. The doctors are not proposing to strike or to put an end to any existing contract, but merely to refuse to make new ones which they consider unfair. In truth, the language that has been used about the strike of the doctors, even by the doctors themselves, is chiefly misleading rhetoric. There is no analogy whatever between the action of the medical profession and that of strikers in the great majority of cases. The doctors are not demanding higher fees and better conditions of work than they get at present, but are merely refusing to accept what they are confident will turn out to be lower fees and worse conditions of work.—*The Spectator*.

SCIENTIFIC BOOKS

The Changing Chinese, Oriental and Western Cultures in China. By EDWARD ALSWORTH ROSS, Ph.D., LL.D., Professor of Sociology in the University of Wisconsin. New York, The Century Co. 1911. 8°. Pp. xvi + 356. Price \$2.40, postage 18 cents.

Almost on the day that the great Chinese insurrection broke out, this book emerged from the press. The coincidence is at least fortunate from whatever point of view one sees it. The book is not exactly a prophecy, and it is still too early to speak of the fulfilment of any one's prophecy. But the reader of the book will be put in possession of facts

and information that will greatly aid him in his efforts to account for the events of to-day.

It is well known that Dr. Ross spent many months in 1910 traveling through China. He went for the express purpose of studying the sociology of China, and although the numerous authors of recent books on the celestial empire have usually had a much longer experience in that country than Dr. Ross, still they have not for the most part gone there for a specific purpose, and their accounts are more or less incidental to other objects that called them there. None of them, so far as I am aware, are professional sociologists, and their observations are chiefly centered on political affairs. Of course they treat social matters too, but only from the ordinary standpoint, and not in a systematic and scientific way. Dr. Ross's equipment for observing social phenomena enabled him to see more in a few months than some would see in many years. It also enabled him to interpret facts in the light of a great store of scientific knowledge of human society in general. Whatever he observed he instantly saw the full meaning of, and was thus able to correlate oriental with occidental conditions. The entire history of the western world was at his command, and by this means he could locate China in its proper part of the historic panorama. Instead of considering the Chinese such a strange people as most observers do, because they are unlike ourselves, he simply ran his eye back along the path of European history till he found the epoch at which Europeans were what the Chinese are now. He found it in the middle ages, and he says:

Not that there is anything queer in the working of the Oriental brain. Not in the least. Their popular thought is unripe, that is all. The bulk of the Chinese match up well with our forefathers between the fourteenth and seventeenth centuries. For in the Middle Ages white men were just as haphazard, casual and uncritical as are the yellow men to-day. They looked for "signs and wonders in the heavens" and trembled at comets. They held that blood-root, on account of its red juice, must be a blood purifier; liverwort, having a liver-

shaped leaf, will cure liver disease; eyebright, being marked with a spot like an eye, is good for eye troubles; and so on. They fasted, exorcized demons, burned witches, trusted talismans, paraded sacred images, wore relics of the saints, sought the king's touch to cure scrofula, marched in religious processions to bring change of weather and hung consecrated bells in steeples to ward off lightning. It was the rise of the natural sciences that cleared the fog from the European brain. In the building of astronomy, physics, chemistry and physiology were wrought out certain methods—observation, measurement, trial and error, experiment—which were as helpful for practical life as for science. For a method that connects cause and effect may also light up the relation between effort and result (pp. 315-316).

In some things the Chinese would seem to belong to a still earlier stage in the development of Caucasian peoples, for the absence of chimneys and glass windows carries us back to the first century of our era. They were unknown to antiquity, but were found in the ruins of Pompeii, which was buried in the year 79 A.D. In their apparent ignorance of the value of milk as food the Chinese go all the way back to the Homeric period.

One of the most important points brought out by Dr. Ross, known of course to others, but little emphasized, is the astonishing confirmation that China furnishes of the great "principle of population" of Malthus. Nearly all the woes that China suffers are due directly or indirectly to the operation of this principle, and we may say, secondarily, to its ignorance of it. We thus read:

For a grinding mass poverty that can not be matched in the Occident there remains but one general cause, namely, *the crowding of population upon the means of subsistence*. Why this people should so behave more than other peoples, why this gifted race should so recklessly multiply as to condemn itself to a sordid struggle for a bare existence can be understood only when one understands the constitution of the Chinese family (p. 96). . . . For adults over-population not only spells privation and drudgery, but it means a life averaging about fifteen years shorter than ours. Small wonder, indeed, for in some places human beings are so thick the earth is literally foul from them. Unwittingly they poison the ground,

they poison the water, they poison the air, they poison the growing crops (p. 104). . . . Here are a people with standards, unquestionably civilized—peaceable, industrious, filial, polite, faithful to their contracts, heedful of the rights of others. Yet their lives are dreary and squalid, for most of their margins have been swept into the hopper for the production of population. Two coarse blue cotton garments clothe them. In summer the children go naked and the men strip to the waist. Thatched mud hut, no chimney, smoke-blackened walls, unglazed windows, rude unpainted stools, a grimy table, a dirt floor where the pig and the fowls dispute for scraps, for bed a mud *kang* with a frazzled mat on it. No woods, grass, nor flowers; no wood floors, carpets, curtains, wall-paper, table-cloths nor ornaments; no books, pictures, newspapers nor musical instruments; no sports nor amusements, few festivals or social gatherings. But everywhere children, naked, sprawling, squirming, crawling, tumbling in the dust—the one possession of which the poorest family has an abundance, and to which other possessions and interests are fanatically sacrificed (pp. 104-105). . . . Utility reigns supreme; and all it comes to is to feed a dirty, sordid, opium-sodden people living in hovels, wearing coarse, faded blue garments, crippling their women by foot-binding, and letting their boys and girls run about filthy and naked! No music, art, books, poetry, worship, refined association, allure of children, charm of women or glory of young manhood in its strength. No discussions, no politics, no heed to events in the great world. Life on a low plane, the prey of petty cares and mean anxieties. Infinite diligence, great cleverness and ingenuity, abundance of foresight and thrift, few destructive passions; still, a life that is dreary and depressing to look upon (p. 287).

Such is the picture. It is this enormous pressure of population that has so reduced the standard of living, and that makes the Chinese people a drove of pigs, rather than a collection of human beings. It is true that they give reasons for it, and that it forms part of their time-honored customs, so that perhaps it may rather be ascribed to error than to ignorance. The result is the same.

The next most striking fact that looms up is the complete improvidence of the Chinese. By this I mean their failure to look forward to the future or to consider the effect of their

social system upon coming generations. It may be called social, as distinguished from individual improvidence. Of the latter, as Dr. Ross shows, they are not guilty. But they seem to have no social consciousness whatever. That has been true of other peoples at their stage of culture, but on account of the density of population in China the results have been more disastrous there than elsewhere. The great "Indo-Germanic" migration of which we hear so much, by which central and western Asia were depopulated, was doubtless largely due to the exhaustion of the natural resources by man's reckless individualism, but evidence is accumulating of the gradual drying up of these regions as a planetary process, which may be general all over the world. This, however, appears to have been inappreciable in eastern Asia; and there is still abundant rainfall. The entire Chinese empire is highly favored by nature in this respect, and the destruction that has taken place is exclusively the work of man. It is customary with us to condemn the feudal system and to deplore the reservation of vast tracts of country by a landed gentry, but the condition of China leads us to question whether Europe, but for this, might not have also been denuded and made uninhabitable for civilized man. On this point Dr. Ross aptly remarks:

If the Chinese had not so early rid themselves of feudalism the country might have profited, as did Europe during the Middle Ages, by the harsh forest laws and the vast wooded preserves of a hunting nobility; or a policy of national conservation would have availed if begun five centuries ago. Now, however, nothing will meet the dire need of China but a long scientific, recuperative treatment far more extensive and thoroughgoing than even the most enlightened European governments have attempted. Since that is clearly beyond the foresight and administrative capacity of this generation of Chinese, the slow physical deterioration of the country may be expected to continue during our time (pp. 24, 27).

Dr. Ross gives a brilliant description of the ruined condition of the country, especially on pages 22-24, too extended to be reproduced here, but which should be read by all who are interested in the conservation movement in

the United States. It shows what we would come to if nothing was done. It is also a lesson to the *laissez faire* economists and is a fair sample of the legitimate consequences of the *laissez faire* policy in general.

Another modern economic doctrine is here exemplified, namely, that of historical materialism, as it is called, otherwise named economic materialism, economic determinism, or the economic interpretation of history. I do not refer to the facts, which of course can be relied upon, and we have them here on a grand scale, but to the contention that economic effects are exclusively the result of impersonal, or, as it were, of physical laws, with which men as men, and human ideas have nothing to do. That the entire series of degrading conditions in China is due to the ideas and fixed beliefs of the Chinese is clear almost at a glance. We have seen that their terrible overpopulation is the result of an inveterate conviction of the duty of unlimited propagation, which nothing seems able to shake. The same is true of most of their other calamities, which a sound philosophy might have averted. On this point Dr. Ross says:

Chinese conservatism, unlike the conservatism of the lower races, is not merely an emotional attitude. It is not inspired chiefly by dread of the unknown, horror of the new, or fanatical attachment to a system of ideas which gives them confidence in the established. It is the logical outcome of precedent. Change the ideas of the Chinese and their policy will change. Let their minds be possessed by a philosophy that makes them doubt the past and have confidence in the future, and they will prove to be as consistently progressive as are the Germans of to-day (pp. 53-54).

It is perfectly clear that the Japanese awakening has been due to a change in their ideas, and when the Chinese similarly change theirs they too will awake and start in a new direction. That the Chinese are not an "inferior" race, that their intellectual capacity is fully equal to that of the Caucasian, nay, of the Aryan race, is clearly brought out in this book, and no one can foresee the results of a development there, should it ever take place, analogous to the intellectual development of Europe since the middle ages.

There are many great subjects treated in this work which space will not permit us more than to mention. One is the condition of women and the prospect of their emancipation. In China, as in India, the androcentric world view is supreme, and its overthrow seems almost hopeless, but progress is being made even here, and foot-binding at least seems destined to disappear. In the relations of the sexes China is certainly medieval if not positively ancient or even barbaric. There is absolutely no mutuality in the choice of partners. None of the three forms of sexual selection to which I gave special names in 1903, viz., gyneclexis, andreclexis and ampheclexis (terms which are defined in the Supplement to the Century Dictionary), can be said to exist in China, but a fourth form, which I did not name, but which may be called *altreclexis*, is universal. This is the selection of wives by third parties—parents, relatives and usually by the house or clan to which the parties belong—and in which neither of the parties to the marriage, least of all the woman, has any voice whatever. Under such a system, which is of course not confined to China, but has widely prevailed in other countries, there can obviously be no romance, and life becomes utterly prosy and uninteresting. But it also shows, as do unnumbered other facts, that there is no psychologic basis in China for a romantic life, that the sentiment underlying it, commonly called romantic love, does not exist in the Chinese constitution, being wanting there as it is in all other races outside of the Caucasian peoples subsequent to the middle ages of European history.

The opium curse of China is treated in an interesting chapter, and the remarkable fact developed is that the crusade against it has been mainly waged by the Chinese themselves. The Christian missionaries residing there, belonging, as they do, to races in which the evil does not exist, have, it is true, cooperated in the movement, but the claim so often made, that they are the chief cause of the progress attained, is utterly unfounded. On the contrary, the strongest resistance that the Chinese

authorities have encountered comes from the British traders, who have taken advantage of the Chinese laws prohibiting the raising of the poppy in China to increase the importation of opium from India. So much for the boasted morality of European nations.

Dr. Ross says nothing of another great moral crusade that the Chinese nation has been long waging, viz., that for the abolition of slavery. For a very full account of that movement we are indebted to Mr. E. T. Williams, who was long Chinese Secretary of the U. S. Legation at Peking, and was made Consul General at Tientsin in the spring of 1908. Mr. Williams is also a sociologist of no mean order, and is conversant with the entire literature of the science. He treated this subject in the *American Journal of International Law* for October, 1910 (Vol. IV., pp. 794-805; Supplement, Official Documents, pp. 359-373), in an exhaustive article entitled: "Abolition of Slavery in the Chinese Empire." The Supplement contains Mr. Williams's translation of the report of the commission recommending the abolition of slavery and the imperial rescript approving it. The whole is reprinted in pamphlet form.

In all matters relating to the influence of Christianity and Christian missionary work in China our author is decidedly partisan. As an American traveling in China, he was of course largely beholden to American and English missionaries for facilities in getting about, and must have seen a wholly disproportionate part of their influence in the country, and it would have ill become him to speak disparagingly of such things, whatever his real views might have been. But his extravagant praise of them, even where it was deserved, should have been tempered by countervailing considerations which everybody knows to exist. His idea of the ultimate conversion of the Chinese to Christianity is probably Utopian. The hint on page 235 that Christianity might ultimately become the "official religion" of the Chinese empire would be alarming if it rested on any basis of fact. The present humble attitude of the few Christian missionaries in China is no criterion. As

Helvetius said: "Christians are lambs when weak, tigers when strong." Christianity is an exclusive religion. It is a militant, proselyting, persecuting religion, in which it differs wholly from Confucianism, Shintoism and Buddhism. If there was any danger that China would have to pass through the ordeal of blood to which Europe has been subjected by Christianity since the middle ages there would surely be grounds for grave apprehension. The Crusades, the Thirty-years War, and the Spanish Inquisition, would be trifles compared to the fanaticism of the whole vast Chinese population, should it ever be seized with the spirit that actuated Europe during six centuries of its unhappy history. If any hope is to be expressed, it should be that there may never be an "official religion" in China, but if there is to be such, let it be one of those tolerant, peaceful and rational forms, that harmonize with all others, permit free discussion and work to the advancement of all moral, material, intellectual and spiritual development.

Of this book, perhaps more than of most others, is the trite remark of the perfunctory reviewer true, that it must be read to be appreciated. The above is not a review of it, but merely a brief mention of a few of the most vital points contained in it. The book is a study in sociology by a leading sociologist, based on direct personal observation, of the numerically greatest people on the globe.

LESTER F. WARD

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Natural History of the American Lobster. By FRANCIS HOBART HERRICK, Ph.D., Sc.D. Document No. 747, from the Bulletin of the Bureau of Fisheries, Vol. 29, 1911. Government Printing Office, Washington, D. C.

There is surely no one acquainted with Professor Herrick's earlier monograph¹ on the lobster, who does not heartily welcome his recent book, "Natural History of the American Lobster."

¹"The American Lobster: A Study of its Habits and Development," *U. S. Fish Commission Bulletin*, Vol. 15, pp. 1-252.

Herrick's monograph of 1895 was an excellent assemblage of original data, bearing chiefly upon the anatomy and development—but to a very slight extent upon the habits—of our most far-famed decapod. The paper was adequately illustrated with original drawings and was accompanied by a bibliography of 213 titles. This was a book which merited a place upon the shelves of every zoologist and student of natural history—a place beside Professor Verrill's "Invertebrates of Vineyard Sound."

At the time of this earlier work, the lobster's main interest for the zoologist lay in the fact that it was an easily obtained "type-specimen"; gastronomically it was well known and appreciated, and the term, lobster, in the discussion of lobster laws, might sometimes have been heard in the halls of legislatures; that was about all. During the last fifteen years, circumstances have changed greatly. This species now finds itself at the focus of several zoological interests, and in legislative assemblies many word-battles have been fought in efforts to do equal justice to the lobster, on the one hand, and to the great American public on the other. The lobster fisheries of the country have become recognized as never before, as a point of great economic importance. The spirit of conservation, coupled with biological incentive, has rendered important the consideration of artificial propagation of marine fauna—a movement in which the propagation of the lobster has been foremost. But in addition to all this, the lobster has become possessed of more subjective interests. Important and instructive as has proved its developmental history, it has become a means of attack upon larger problems. As a subject for the study of regeneration and problems in morphogenesis, the lobster has supplied valuable material; and metamorphic transitions in cellular and tissue elements have been more clearly revealed through histological researches upon this invertebrate. Moreover, the student of animal behavior, a branch of study which, at the time of Herrick's earlier report, had scarcely emerged from the general field of nat-

ural history, has found in this crustacean a subject of value with reference to the investigation of problems in comparative psychology, instinct and habit-formation in lower animals. Both in this country and in Europe, many eyes have been turned upon *Homarus* and during the past six or eight years, alone, several important contributions based upon the study of this crustacean have been made. Indeed, as Herrick states, there is probably at the present time no invertebrate in the world better known than the American lobster.

Such a growing interest in *Homarus* can readily explain why it is that in Herrick's new publication we find 408 pages as compared with 252 in his earlier report; and why the bibliography has expanded from 213 to 329 titles. But this increased outside interest in the lobster does not account entirely for the greater proportions of the present work, since the author himself, through his continued studies, has added much, both in the text and in valuable illustrative features.

The subject matter of the book is presented in twelve chapters, which have the following headings: (1) The Lobsters and Allied Crustacea; their Zoological Relations, Habits, Development and Use as Food; (2) The American Lobster; its Economic Importance and General Habits; (3) Giant Lobsters; (4) Molt-ing; (5) Enemies of the Lobster; (6) The Anatomy of the Lobster, with Embryological and Physiological Notes; (7) The Great Forceps, or Big Claws; (8) Defensive Mutilation and Regeneration; (9) Reproduction; (10) Development; (11) Behavior and Rate of Growth; (12) The Preservation and Propagation of the Lobster.

The text of these chapters has been practically rewritten and many valuable additions have been made. These additions relate to chapter I., with its section on the "natural history of the Crustacea," to chapter VI., with the much more complete references to the internal anatomy, especially of the nervous system and its connections; to chapter VII., with its added sections discussing symmetry, asymmetry and torsion, data largely supplied by Herrick's recent investigations;

to chapter VIII., with fundamental additions to our knowledge of the regenerative process, and embodying the excellent work of Emmel; to chapter XI., bringing in an almost new section concerning the behavior of the lobster; and, finally, to chapter XII. (and also to part of chapter I.) discussing the economic importance of the lobster fisheries in this country and considering means of preservation and propagation.

In this last chapter, Herrick frankly considers the question, "What is the matter with the lobster?" and discusses very fully the pros and cons of all methods, legislative and otherwise, suggested for its protection. "Unfortunately for many years," says the author, "we have watched this race decline until some have even thought that commercial extinction, and that not far remote, awaited the fishery. . . . If this is primarily a scientific question, the zoological history of the animal should give us the answer. . . . The main biological facts . . . are now well in hand, and excuse can no longer be offered on the ground of ignorance."

After showing by means of convincing statistics the fact of the decline in the lobster fishery in this country, Herrick considers the cause.

More lobsters have been taken from the sea than Nature has been able to replace by the slow process of reproduction and growth. In other words, man has been continually gathering in the wild crop, but has bestowed no effective care upon the seed. The demands of a continent steadily increasing in wealth and in population have stimulated the efforts of dealers and fishermen, who must work harder each year for what they receive in order to keep up the waning supply. The natural result has followed, namely, a scarcity of numbers and a decrease in the size of the animals caught, with steadily advancing prices paid for the product. This is precisely what we should expect, had we based our judgment upon any sound principles of common sense and human economy, not to speak of a knowledge of the mode of life and general natural history of the animal in question.

Herrick shows that all measures which have heretofore been adopted in this country to

check the decline have failed, and it can be concluded that "either the laws are defective or the means of enforcing them are insufficient." Since a *closed season* for any animal, to have protective value, must correspond with the breeding season, and since this is impossible in the case of the female lobster (which spawns only once in two years and carries its eggs externally for about a year), closed seasons are not recommended as a possible means of improving conditions.

Moreover, legislation calculated to protect the "berried" lobsters has not been successful, because many fishermen evade the law by combing the eggs from the abdomen of the female. In addition, Herrick clearly points out that, even if an egg-lobsster law could be enforced, the protection aimed at must necessarily be reduced by one half, since the adult females lay eggs but once in two years, and therefore, at any given time only one half of them would be "in berry." The plan sometimes followed, of enclosing the "berried" females in crates and allowing the eggs to hatch naturally, Herrick thinks commendable, but inadequate for the preservation of the fishery.

As to the gauge law, while admitting that it has scarcely ever been thoroughly enforced in any locality, Herrick also believes this to be inadequate, whether short lobsters are destroyed or not.

First, by legalizing the capture of the large adult animals, above 10½ inches in length, we have destroyed the chief egg-producers, upon which the race in this animal, as in every other, must depend. Second, as supporting or contributory causes, some of us now, like others in the past, have entertained false ideas upon the biology of this animal, especially (a) upon the value of the eggs or their rate of survival, that is, the ratio between the eggs and the adults which come from them, and (b) of the true significance to the fisheries of the breeding habits, especially in regard to time and frequency of spawning and the fosterage or carriage of the eggs. Our practises have been neither logical nor consistent, for, while we have overestimated the amount of gold in the egg, we have killed the "goose" which lays it. We have thought the eggs so valuable that we have been to great

trouble and expense in collecting and afterwards hatching them and committing the young to the mercy of the sea, while we have legalized the destruction of the great source of the eggs themselves—the large producing females.

And again Herrick states:

This race needs eggs, not by the tens of thousands merely, but by the tens of billions, and it must have them or perish. Moreover, it can get them only, or mainly, through the big producers, the destruction of which the present gauge laws have legalized. If the lobster is a good incubator, the sea is a very poor nursery.

Thus Herrick brands as thoroughly ineffective any gauge law which protects the female lobster merely to the 9, 10 or 10½ inch limit. This limit enables them to lay, in all probability, but a single lot of eggs, usually not more than 10,000, and, according to Herrick's estimate, only one lobster out of 15,000 eggs reaches maturity.

Analyzed in the light of the law of survival (one out of 15,000 eggs), Herrick does not look upon the showing of the lobster hatcheries as very encouraging, since, to hold the lobster fishery at an equilibrium would require the hatching of larvæ by the trillions; we can not work on such a scale. In the method of rearing the young through the critical or larval period, as practised at the Wickford Experiment Station of the Rhode Island Commission of Inland Fisheries, Herrick, however, sees great possibilities of material aid to the lobster fishery.

The chapter on Preservation and Propagation concludes with a set of five recommendations devised to protect the lobster fishery. These are worth presenting in full:

1. Adopt a double gauge or length limit, placing in a perpetual close season or protected class all below and all above these limits. Place the legal bar so as to embrace the average period of sexual maturity, and thus to include what we have called the intermediate class of adolescents, or smaller adults. These limits should be approximately 9 inches and 11 inches, inclusive, thus legalizing the destruction of lobsters from 9 to 11 inches long only when measured alive. In this way we protect the young as well as the larger adults, upon which we depend for a continuous supply of eggs. The

precise terms of these limits are not so vital, provided we preserve the principle of protecting the larger adults.

2. Protect the "berried" lobster on principle, and pay a bounty for it, as is now done, whether the law is evaded or not, and use its eggs for constructive work, or for experimental purposes with such work in view.

3. Abolish the closed season if it still exists; let the fishing extend throughout the year.

4. Wherever possible, adopt the plan of rearing the young to the bottom-seeking stage before liberation, or cooperate with the United States Bureau of Fisheries or with sister states to this end.

5. License every lobster fisherman, and adopt a standard trap or pot which shall work automatically, so far as possible in favor of the double gauge, the entrance rings being of such a diameter as to exclude all lobsters above the gauge, and the slats of the trap of such a distance apart as to permit the undersized animals to escape.

If the double gauge should prove ineffectual because of not being uniformly adopted or rigidly enforced, Herrick recommends the following steps with reference to the maintenance of the present laws:

1. Raise the legal gauge to 10½ inches wherever it now stands below this limit.

2. License every lobster fisherman, and adopt a standard trap, with slats of sufficient distance apart to permit the undersized lobsters to escape.

3. Destroy the enormously destructive interstate commerce in short lobsters.

4. Do not turn another larval lobster into the sea, but devote the energy expended in lobster hatcheries to rearing these young to the bottom-seeking stage after the methods now successfully practised at Wickford, R. I.

To conclude, it may be said that this volume on the American lobster is written in a clear and fascinating style, by virtue of which it will find approval in the hands of many classes of readers. To the scientifically minded it will be a mine of information, exact, well-classified and marvelously complete; to the ordinary reader it will prove an entertaining essay and study in natural history, while to those especially interested in the preservation and propagation of the lobster, it should serve as a trustworthy guide

for adequate legislation and for effective control of the lobster fishery.

PHILIP B. HADLEY

KINGSTON, R. I.

Farmers of Forty Centuries, or Permanent Agriculture in China, Korea and Japan.

By F. H. KING, D.Sc. Published by Mrs. F. H. King, Madison, Wis. 8vo. Pp. 441, 248 illustrations. 1911.

A more wholesome work at the present stage in agricultural agitation in this country could scarcely be written; nor could it well come from one better fitted to write it, for the tenor of the story falls closely into line with Professor King's intensive studies on soil management. In a very peculiar sense the art of soil management in distinction from soil science constitutes the theme of this work. Until recently, the Chinese, Japanese and Koreans were almost wholly without formal agricultural science in the western technical sense, while they have for centuries been adepts of unsurpassed skill in agricultural practise. The story of Professor King is not the less weighty because he has seemed to lean a little at times to the tide of Occidental opinion that has set rather strongly heretofore toward chemical analysis as the decisive mode of attack and source of guidance, and he can not be thought partial in setting forth the attainments of Oriental peoples who have worked in almost entire negligence of all resources but those of the farm, the home and the town. "Farmers of Forty Centuries" is in effect a sketch of domestic methods of nursing crops.

As Dr. Bailey intimates in a graceful preface to the book, Dr. King has played well the rare part of "an agricultural traveler" and his results are quite on the high level of those other traveling experts who set forth natural features or social phenomena with expert touch. Professor King crossed Japan and touched eastern China on his inward trip, but his serious work only commenced when he reached the tropical border of south China and began to work northward with the advancing season. This put him in the way of critically following the modes of treatment in

vogue just at the transition from the winter crops to the spring and early summer crops. These combined at once the maturing and the harvesting of the one and the fitting, the planting and the early culture of the other. Thus he advanced by stages—looping back for restudy midway—from the tropical border in Kwangtung and Kwangsi, into Chekiang and Kiangsu in the latitude of our southern states, later into Shantung and Chili in latitudes comparable to Kentucky and Illinois, and at length into Manchuria, whose climate is comparable to that of our distinctly northern states. Passing through Korea, he was guided in a further study of Japan by details from the Japanese agricultural stations in which western science has already joined hands with Oriental experience with the happiest results.

King's treatment is everywhere sympathetic and appreciative. He is singularly free from the Occidental provincialisms that mar so many stories of Oriental travel. He seems to have carried at all times the trained sense of the agriculturalist and of the student of fertilization, not the sniffing nose of the typical westerner. He seems in no wise to have been squeamish about inevitable organic odors, but yet was keen enough to note the singular scarcity of flies and to draw the inference that it meant a vital order of cleanliness and carried a sanitary significance. In the universal use of hot tea-tinctured drinks he saw as other incisive travelers have done an important protective custom. Nowhere does he lapse into grewsome pictures of putative decimations due to invited diseases. His tale is that of a fair-minded friendly visitor seeking to learn, and his story is in grateful contrast to the irksome animadversions of the commonplace Occidental writer who plumes himself on looking down on Oriental customs "e superiore loco," as Caesar would say.

King's statements are larded with quantitative data and carry a wealth of precise fact brought close home to the special cases of individual farmers or particular practises. The smallness of the farms, the largeness of the product, the lavishness of the labor and a multitude of special items relative to specific

crops, modes of handling, costs of fertilization, and largeness of population per unit area, make the book a thesaurus of its kind.

The author, like the reviewer whose educational studies in China ran contemporaneously with these agricultural ones, was impressed with the extent of resources still unused in the very regions whose overcrowded condition has been so common a theme of lugubrious comment. Scattered through the volume there are economic points of the most vital pith that should serve as an antidote to the pessimistic Jeremiads so current in these days and so commonly floating on very shallow waters. The following quotation from the final chapter on Japan, p. 425, must suffice to indicate the tenor of the author's outlook on future possibilities:

In 1907 there were in the [Japanese] Empire some 5,814,362 households of farmers tilling 15,201,969 acres and feeding 3,522,877 additional households, or 51,742,398 people. This is an average of 3.4 people to the acre of cultivated land, each farmer's household tilling an average of 2.6 acres.

The lands yet to be reclaimed are being put under cultivation rapidly, the amount improved in 1907 being 64,448 acres. If the new lands to be reclaimed can be made as productive as those now in use there should be opportunity for an increase in population to the extent of about 35,000,000 without changing the present ratio of 3.4 people to the acre of cultivated land.

While the remaining lands to be reclaimed are not as inherently productive as those now in use, improvements in management will more than compensate for this, and the Empire is certain to quite double its present maintenance capacity and provide for at least a hundred million people with many more comforts of home and more satisfaction for the common people than they now enjoy.

The soul of the book lies in its appreciative delineation of methods that have sufficed for the maintenance through many centuries of perhaps the highest average productivity ever attained by great peoples, and its chief lesson lies in the realization of this by simple domestic means. The style of the book is excellent and the two hundred and forty odd half tones effectively illustrate the text.

That this should be the last contribution of one who has written so much and so well is a source of inexpressible regret.

T. C. CHAMBERLIN

SCIENTIFIC JOURNALS AND ARTICLES

THE closing (October) number of volume 12 of the *Transactions of the American Mathematical Society* contains the following papers:

W. A. Manning: "On the limit of the degree of primitive groups."

G. A. Miller: "Isomorphisms of a group whose order is a power of a prime."

John Diesland: "On minimal lines and congruences in four-dimensional space."

G. C. Evans: "Volterra's integral equation of the second kind, with discontinuous kernel. Second paper."

E. J. Wilczynski: "One-parameter families and nets of plane curves."

Also: "Notes and errata, volumes 10 and 11."

THE December number (volume 18, number 3) of the *Bulletin of the American Mathematical Society* contains: "A generalization of Lindelöf's theorems on the catenary," by Oskar Bolza; "A note on the theory of summable integrals," by S. Chapman; "Irreducible homogeneous linear groups of order p^m and degree p or p^2 ," by W. B. Fite; Report on "Graduate work in mathematics in universities and in other institutions of like grade in the United States," by the American committee of the International Commission on the Teaching of Mathematics; "Shorter Notices": Holton's Shop Mathematics, by C. N. Haskins; Timerding's Die Mathematik in den physikalischen Lehrbüchern, and Siddons and Vassall's Practical Measurements, by E. W. Ponzer; Hosmer's Azimuth, by E. B. Wilson; "Eisenhart's Differential Geometry," by G. A. Bliss; "Note on collineation groups," by H. H. Mitchell; "Notes"; "New Publications."

THE January number of the *Bulletin* contains: Report of the October meeting of the society, by F. N. Cole; Report of the October meeting of the San Francisco Section, by T. M. Putnam; "The Karlsruhe meeting of the German Mathematical Society," by Virgil Snyder;

"A new proof of the existence theorem for implicit functions," by G. A. Bliss; "On a set of kernels whose determinants form a Sturmian sequence," by H. Bateman; "On the cubes of determinants of the second, third and higher orders," by R. E. Moritz; "Note on the maximal cyclic subgroups of a group of order p^m ," by G. A. Miller; "An expression for the general term of a recurring series," by Tsuruichi Hayashi; "Shorter Notices": Lebon's *Biographie et Bibliographie* of Emile Picard and Paul Appell, by J. W. Young; *Vermeintliche Beweise des Fermatschen Satzes*, from the *Archiv der Mathematik und Physik*, and Lind's *Ueber das letzte Fermatsche Theorem*, by Joseph Lipke; Slaughter and Lennes's *Solid Geometry*, by F. W. Owens, Hawkes, Luby and Touton's *First Course in Algebra*, by J. V. McKelvey; "Corrections"; "Notes"; "New Publications."

WHEAT RUSTS AND SUNSPOTS

In looking over a copy of the *Journal of the Agri-Horticultural Society of Western India* for April to June, 1906, I was interested to notice, on page 165, an article with the above caption, by G. N. Sahasrabudhe, of the College of Agriculture at Poona. The author refers to a report in the *Proceedings* of the Australian Wheat Conferences of periodicity in the occurrence of *Puccinia graminis* in Australia. The years of the most severe attacks, it is stated, were 1867, 1878 and 1889, making a period of eleven years between every two maximum years. The writer goes on to state that this cycle suggested to some members of the conference that it had some relation with the various phases through which the fungus has to go, but quotes from Surgeon-Major D. Prain the statement that "the periodicity is not due to any inherent property of the fungus, but must, as seems to be the belief in Chili, be due to the recurrence of conditions favorable for its development."¹ I quote the following paragraph entire:

We have trustworthy records of rust attacks in Australia from 1867. In that year it was almost

general and caused immense loss in South Australia. This is the minimum year of the sun-spot cycle (1867-78). The year 1878 was one of the worst years for rust in Victoria, and in South Australia it prevailed over a large area that year; that also was the minimum year of the sun-spot cycle. In South Australia 1880 was the year when a considerable area was affected; and it was the year when the sun-spot area was very small. The seasons 1882-1888 seem to have been very free from rust; and that was the maximum period of the sun-spot cycle (1879-1889). In 1889 it was almost general and caused great loss in South Australia, Victoria, New South Wales and Tasmania; and that was the minimum year of the sun-spots. This clearly proves that the attack of the pest is most severe when the sun-spot area is the smallest, and from the theory of the sun-spots it does not seem unnatural. It is well known that the changes in sun-spots are closely related to the changes in the atmospheric pressure and consequently in the rainfall; and experience shows that the development of the fungus is dependent to a great extent on the atmospheric conditions and rainfall. The opinions of the farmers put forward in the Second and Third Conferences indicate the same thing. Rust is usually most prevalent in seasons when the rainfall is excessive, especially during October and November.² When close, damp, muggy weather sets in, the rust is certain to appear (indicating diminution in pressure). A dry cold season in Queensland is inimical to rust. The year 1889, which was a very rusty one, was marked in New South Wales by frequent thunderstorms at the time the wheat was in bloom. The colder districts were in that year less rusty than others.

The author states that when he thought the matter over, especially the remark by Dr. Prain, he thought there must be some relation between this eleven-year cycle and the Brookner's cycle of sunspots, which is also of eleven years, and that when he began to compare the two cycles closely, he was "almost convinced" that there must be some relation between sunspots and the growth of the *Puccinia* fungus. This relationship, he concludes, may "throw a great light on the life history of the fungus and also we may be able to foretell the years in which the rust attacks will

¹ Agri. Ledger, No. 16 of 1897, p. 9.

² Proc. of II. Con., 17, 49.

be severe from the observation of the sun-spots."

A hasty survey of the literature concerning the occurrence of *Puccinia*, and brief correspondence or personal conferences with some of our American botanists failed to reveal any knowledge of this hypothesis, and although it is not probable that it is of any great importance, I thought it would be of sufficient interest to be placed on record in an American publication.

C. STUART GAGER

BROOKLYN BOTANIC GARDEN

SPECIAL ARTICLES

TIER-LIKE ARRANGEMENT OF THE ELEMENTS OF CERTAIN WOODS

THERE are numerous woods which present on longitudinal section (particularly the tangential) fine, delicate cross lines or stripes sometimes called "ripple marks." The distance between these markings varies from 0.11 to 0.50 mm., and is fairly constant for a species. On some woods (e. g., *Æsculus octandra* Marsh., *Swietenia mahagoni* Jacq., *Bombax insigne* Wall. and *Pterospermum diversifolium* Blume.) these lines are very clear and distinct to the unaided eye; on others (e. g., *Tilia americana* L., *T. pubescens* Ait., *Pterocarpus indicus* Willd. and *P. dalbergioides* Roxb.) they are near the limit of vision or again (e. g., *Guaiacum sanctum* L. and *G. officinale* L.) they are invisible without the lens. In most species showing these markings the feature is constant and of considerable importance for diagnostic purposes, though in a few species (e. g., *Swietenia mahagoni*) the same piece of wood may show the markings in one place and not in another.

This cross-striping of a wood is due (1) to the arrangement of the rays in horizontal series, or (2) to the tier-like ranking of the wood fibers, vessel segments or other elements, or (3) to a combination of (1) and (2). The lines resulting from the horizontal seriation of the rays is usually more conspicuous and of more common occurrence than those in (2). In the combination of the two forms, which is very common, the junction of the vessel

segments or of the fibers is usually between the rays.

This peculiar arrangement of wood elements is also evidenced on transverse section. Where the rays are in perfect horizontal seriation a section between two tiers shows an entire absence of rays. In most instances, however, it results in gaps of irregular width depending upon the regularity of the stories. Where the rays are much wider near the middle than at the margin their apparent width when viewed transversely will show considerable variation, according to the relative location of the plane of section. Where the fibers are arranged in tiers their apparent size is affected in a similar manner. According to von Höhnelt¹ the fibers in *Bocoa provocensis* Aubl., and a few other tropical woods with cross-striping are also radially disposed, and when the plane of cutting passes near the junction of two tiers the section shows large and small cells in alternate radial rows. The small cells are sections of the tips of the fibers forced by growth between their upper and lower neighbors. It is von Höhnelt's theory that their appearance in alternate radial rows instead of alternately in the same row is the result of the pressure of the bark upon the cambium while the fibers were being formed.

Tier-like arrangement is most common in tropical woods and has been found fairly characteristic of the families Cæsalpiniaceæ and Zygophyllaceæ. Various writers² have

¹ Von Höhnelt, Franz Ritter, "Ueber stockwerkartig aufgebaute Holzkörper," *Sitzungsberichte der Mathematische-Naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften*, Vol. 89, Part 1, Wien, 1884, pp. 30-47. Von Höhnelt, Franz Ritter, "Ueber den etagenförmigen Aufbau einiger Holzkörper," *Berichte der Deutschen Botanischen Gesellschaft*, Vol. II., Berlin, 1884, pp. 2-5.

² Flückinger, J. A., "Pharmacognosie der Pflanzen," 2d ed., pp. 463, 466. Wigand, A., "Anatomische Atlas zur pharmaceutischem Werkende," 1865, tables 26, 27. Whitford, H. N., "The Forests of the Philippines," Bul. 10, Bureau of Forestry, Manila, P. I., 1911, Vol. II., p. 36.

called attention to this feature which is especially striking on red sanders (*Pterocarpus santalinus* L. f.), narra (*P. indicus* Willd.), and Jamaica quassia (*Picrasma excelsa* Planch.). Von Höhnelt (*loc. cit.*) observed it in about 80 different woods, all tropical or sub-tropical but one (*Diospyros virginiana* L.), and most of them unidentified. His list of the identified woods includes 35 genera of 12 families, viz., Cæsalpiniaceæ, Papilionaceæ, Mimosaceæ, Zygophyllaceæ, Bittneraceæ, Malvaceæ, Cedrelaceæ, Bignoniaceæ, Simarubaceæ, Ebenaceæ, Rosaceæ and Sapindaceæ.

Included in v. Höhnelt's list are two species which occur in the United States, viz., *Swietenia mahagoni* and *Diospyros virginiana*. In addition to these two the present writer has observed tier-like arrangement in the woods of *Æsculus octandra*, *Tilia americana*, *T. pubescens*, *T. heterophylla* Vent. and *Guaiacum sanctum*.

ÆSCULUS (BUCKEYE)

In the wood of *Æsculus octandra* the rays are fine, uniseriate, uniform, inconspicuous, mostly 10-12 cells high, measuring about 0.25 mm. The average distance between the rays is, vertically, 0.15 m.; laterally, 0.06 mm. Their arrangement is in horizontal series, very regular on the radial section but forming somewhat wavy lines on the tangential, though always plainly visible to the unaided eye. The vessel segments are from 0.35 to 0.40 mm. long and are in series, the horizontal planes of their perforations alternating with the rays. The fibers appear not to be in storied arrangement.

The cross-markings on tangential surface are characteristic of *A. octandra* and were not observed in *A. glabra* Willd., *A. californica* Nutt. or *A. hippocastanum* L., though all three show indistinctly on radial surface a tier-like arrangement of the wood elements. This feature is thus important in separating the wood of *A. octandra* from others of the genus.

TILIA (BASSWOOD)

Tier-like arrangement of the wood elements is characteristic of the woods of *Tilia ameri-*

cana, *T. pubescens* and *T. heterophylla*. The ending of the vessel segments, wood fibers and wood parenchyma fibers is quite uniform. The rays are widely variable in size and are irregularly spaced. The small rays are uniseriate and mostly 10-15 cells high; the largest are 3-5 cells wide and 50-100 cells high. The cells are small and much flattened laterally.

The cross-markings of *Tilia* are not conspicuous, but in proper light are usually readily visible to the unaided eye. The average height of the tiers is about 0.40 mm.

SWIETENIA (MAHOGANY)

Tier-like arrangement is often characteristic of the true mahogany (*Swietenia mahagoni*). While it may be absent, it is quite often very conspicuous. When present the tiers vary in height from 0.35 to 0.50 mm. The rays are deep crimson in color, fusiform, and quite irregular in size; 1-5, mostly 2 or 3, cells wide, and 4-20, mostly 10-15, cells high. When the rays are in storied arrangement they coincide with the vessel segments.

Swietenia senegalensis Deso. is said by von Höhnelt (*loc. cit.*) to be without cross-stripping.

DIOSPYROS (PERSIMMON)

In *Diospyros virginiana* the rays are very numerous, composed of large cells in 1-2 (rarely 3) rows, and from 2-14, usually 10-12, cells high. They are arranged in horizontal series which correspond with the vessel segments, wood fibers and wood-parenchyma fibers. The arrangement is often somewhat irregular and is never conspicuous, though clearly visible to the unaided eye. The height of the tiers is about 0.35 mm. The horizontal seriation of the rays appears to have been first described by Molisch.*

Available specimens of the wood of *D. texana* Sch. do not exhibit the cross-markings.

* Molisch, H., "Vergleichende Anatomie des Holzes der Ebenaceen und ihrer Verwandten," *Sitzungsberichte der Mathematische-Naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaft*, Vol. 80, Part I., Wien, 1879.

GUAIAECUM (LIGNUM-VITÆ)

The wood of *Guaiaecum sanctum* exhibits very fine and quite uniform cross-markings, visible with the aid of the lens. The rays are very fine, uniseriate, mostly 5-7 cells high, deeply colored, appearing under lens like fine hachures. The height of the tiers varies from 0.15 to 0.18 mm. The scattered vessels are filled with a dark-colored resin which adds to their prominence. The vessel segments alternate with the rays.

Guaiaecum officinale L. is similar to *G. sanctum* in the arrangement of the wood elements. The distance between markings is often as low as 0.11 mm. The rays are about 0.05 mm. apart laterally and 90 μ vertically.

In addition to those mentioned above, the writer has observed many tropical woods (particularly African and Brazilian) with tier-like arrangement of their elements.

SAMUEL J. RECORD

YALE FOREST SCHOOL

A SCLEROTINIA ON APPLE

PRIOR to 1902 the fungus causing the brown rot of fruit, both drupaceous and pomaceous, was, at least in this country, commonly referred to *Monilia fructigena*. Norton¹ observed the perfect stage of the fungus on peach, and called it *Sclerotinia fructigena* (Persoon) Schroeter. Coincident with Norton's work on the *Sclerotinia*, Aderhold,² of Germany, was making a study of some forms of this genus and was able to secure a perfect stage of a *Monilia* on apple. He has published good evidence that the form of *Sclerotinia* he found on apples was *Sclerotinia fructigena* (Persoon) Schroeter, and that the form Norton found on peach was *Sclerotinia cinerea* (Bon.) Schroeter instead of *S. fructigena*, although this name has not since been taken up by American authors.

Aderhold was the first investigator to report the perfect stage of *Monilia* or brown rot

¹ Trans. Acad. Sci. St. Louis, Vol. 12, p. 91, 1902.

² Ber. Deutsch. Bot. Land. Ges., Vol. 22, p. 267, 1904. Aderhold and Ruhland, *Arbeit. Biol. Abt. Land. Forst. Gesandh.*, Vol. 4, p. 29, 1905.

fungus on apple, and it has not, so far as I know, been reported since.

I have recently (November, 1911) obtained apothecia of *Sclerotinia* upon mummied apples, which were strikingly different in some respects from those described by Aderhold. These were produced by placing mummied apples in a greenhouse during April, 1911. The mummied fruits were lying upon the surface of the soil and were of course subjected to alternate wetting and drying. During the following summer the greenhouse was neglected and the mummies became very dry, which may to some extent account for the growth of the apothecia later on during the season. The sclerotia remained apparently dormant until a light heat was applied in the building during November. They were first observed by me November 13, 1911. The temperature in the greenhouse at this time was very similar to that of spring conditions, which, I think, was mainly responsible for the growth of the apothecia.

When collecting these decayed fruits only those were selected that were thought to have been grown two seasons previously. Of a dozen or more mummies placed in the greenhouse, all disappeared during the summer but eight; of these eight, five produced forty-one apothecia.

The apothecia arose from the characteristic sclerotia of this genus. The cups varied in size from one to four mm. across. When young they were decidedly campanulate, then flattening to a disk and later becoming cup-shaped again. In color they varied from a cinnamon-brown to gray, when mature.

The mummies were all lying upon the surface of the soil, therefore there was no necessity for a long growth of stipe. Its length ranged on the average from 1 to 2.5 mm. One stipe made a growth of one half centimeter.

In general, the parts of the apothecia are very similar to those growing upon peach, and also to those described by Aderhold as growing upon apple. The most striking dissimilarity is in size, the new form being much smaller.

The asci measure 44 to 64 microns long and

4 to 6 microns wide. The spores are oblong, somewhat pointed at both ends, 6 to 8 microns long and 2 to 3 microns wide. The paraphyses which are very numerous and which vary somewhat from filiform to clavate, are 40 to 60 microns long and 1 to 3 microns wide.

TABLE GIVING THE COMPARATIVE MEASUREMENTS OF THE PEACH AND APPLE SCLEROTINIAS

	Asci	Asco- spores	Para- physes	Apothe- cia	Stipe
Peach	89.3-10.26 μ by	6.2-9.3 μ by			3-5 cm. long
Apple (Demaree)	5.9-6.8 μ 44-54 μ by	3.1-4.6 μ 6-9 μ by	40-60 μ by	1-4 mm. across	1-5 cm. long
Apple (Aderhold)	6-8 μ 120-180 μ by	2-3 μ 11-12.5 μ by	1-3 μ 175-180 μ by	1 mm. across	.5-15 cm. long
	9-12 μ	5 6-6.8 μ	2-5 μ		

The above table shows very plainly the dissimilarity of the forms found by Aderhold and those found here. In every respect the different parts of the *Sclerotinia* are smaller than those described by the German investigator.

It is to be regretted that I was unable to produce any growth from the ascospores, though they were tried in various cultures, including fruit and cooked apples; therefore there is no proof of any connection with a conidial form of *Sclerotinia*. But it seems evident that this is a new *Sclerotinia*, although it may be, and it is my supposition that it is, the perfect form of the fungus causing the brown rot of apples in this country. It may, however, be the perfect stage of *Monilia uredoformis* Ellis & Everhart* which has been reported as growing upon apples. If so *Monilia uredoformis* Ell. & Ever. would be referred to *Sclerotinia* as *Sclerotinia uredoformis*, although it is very obvious that this can not be done until *Monilia* spores can be produced from the new form. The investigation of this *Sclerotinia* will be continued and I hope to be able to report something more definite later.

J. B. DEMAREE

MARYLAND AGRICULTURAL COLLEGE,
COLLEGE PARK, MARYLAND

* *Proceed. Acad. N. Sc. Phil.*, 1893, p. 461.

THE AMERICAN SOCIETY OF NATURALISTS

THE twenty-ninth annual meeting of the American Society of Naturalists was held in Guyot Hall of Princeton University on December 28.

The eastern and central branches of the American Society of Zoologists so arranged their program that members were enabled to attend the Naturalists' meeting. Many members of the Association of Anatomists, which also met at Princeton, attended the program. Although the Botanical Society met elsewhere, a number of botanists were present. It may fairly be said, judging from the attendance of the sessions, that the Naturalists' Symposium was the central feature of the entire Princeton meetings.

The Anatomists, Zoologists and Naturalists had a joint smoker at the Princeton Inn on Wednesday evening.

The Naturalists' dinner was given on Thursday evening at the Princeton Inn. More than one hundred persons were present, this being the largest attendance for a number of years. After the dinner the president, Professor H. S. Jennings, delivered his address on "Heredity and Personality." This splendid address was most enthusiastically received and has been published in the December 29th number of SCIENCE.

The scientific program of the meeting was given on Thursday, both forenoon and afternoon.

The forenoon meeting was devoted to a discussion of "The Relation of the Experimental Study of Genetics to the Problems of Evolution." The following papers were presented:

E. G. Conklin (Princeton University): The Problems of Evolution and the Ways they may be best Attacked.

C. B. Davenport (Carnegie Institution): Light thrown by the Experimental Study of Heredity upon the Factors and Methods of Evolution.

W. Johannsen (University of Copenhagen): Modern Exact Genetics in relation to the Problems of Evolution.

H. F. Osborn (American Museum of Natural History): Unit Characters, Continuity and Discontinuity, as observed by the Paleontologist.

H. L. Clark (Museum of Comparative Zoology, Harvard University): Pure Lines and Phylogeny.

At the afternoon session papers on Genetics were read as follows:

B. M. Davis (University of Pennsylvania): Further Hybrids of *Oenothera biennis* and *O.*

grandiflora that resemble *O. lamarckiana* (with demonstrations).

W. Johannsen (University of Copenhagen): Some Mutations in Pure Lines of Beans.

G. H. Shull (Carnegie Institution): New Place Effects and the Genotype Concept.

R. Pearl (Maine Agricultural Experiment Station): On the Mechanism of Inheritance of Fecundity in the Domestic Fowl.

T. H. Morgan (Columbia University): Associative and Mendelian Inheritance.

E. B. Wilson (Columbia University): Some Problems of Cytology in relation to the Study of Genetics.

D. H. Tennent (Bryn Mawr College): The Correlation between Chromosomes and Particular Characters Exhibited in Hybrid Echinoid Larvæ.

H. D. Goodale (Carnegie Institution): Castration in relation to Secondary Sexual Characters in Brown Leghorns.

R. K. Nabours (Kansas State Agricultural College): Inheritance in the Grouse Locust (with demonstrations).

H. J. Webber (Cornell University): The Inheritance of Characters in Peppers.

All of the papers read before the Society will appear in series in the forthcoming numbers of *The American Naturalist*.

The following were elected to membership in the Naturalists: Alice M. Boring, University of Maine; H. L. Clark, Harvard University; C. D. Congdon, Cornell Medical School; H. K. Hayes, Connecticut Agricultural Experiment Station; E. P. Humbert, New Mexico Agricultural Experiment Station; F. Payne, University of Indiana; H. D. Senior, New York University and Bellevue Medical College; L. H. Smith, University of Illinois; L. R. Waldron, North Dakota Agricultural Experiment Station.

The following officers were elected for 1912:

President—Professor E. G. Conklin, Princeton University.

Vice-president—Professor R. G. Harrison, Yale University.

Secretary—Professor A. L. Treadwell, Vassar College.

Treasurer—Professor W. E. Kellicott, Goucher College.

Additional Members of the Executive Committee—Professor B. M. Davis, University of Pennsylvania; Professor H. E. Jordan, University of Virginia.

CHAS. R. STOCKARD,

Secretary 1911

THE WASHINGTON MEETING OF THE AMERICAN CHEMICAL SOCIETY

AGAIN the American Chemical Society has held the largest meeting in its history, 658 members and guests registering in Washington, and probably 700 were present.

The meeting opened on Wednesday, December 27, with a joint meeting of the Section on Chemical Education and the Division of Physical and Inorganic Chemistry, at which the following four papers were given:

A. A. Noyes (chairman): The Teaching of Physical Chemistry.

W. D. Bancroft: Physical Chemistry in the Introductory Course.

H. C. Jones: The Introduction of Physical Chemical Conceptions in the Early Stages of the Teaching of General Chemistry.

J. Howard Mathews: Some Applications of Color Photography in the Teaching of Physical Chemistry (illustrated).

In the afternoon the address of Vice-president Frankforter, of Section C, entitled "The Resins and their Chemical Relations to the Terpenes," was delivered before a large audience and was followed by an address by Chairman H. P. Talbot on the subject "Privileges and Responsibilities of the Chemical Analyst." Following Dr. Talbot, Dr. A. L. Voge, of the Library of Congress, read a paper on "Ostwald's Proposed International Institute of Chemistry."

Throughout the week the society's Divisions of Agricultural and Food Chemistry, Biological Chemistry, Industrial Chemists and Chemical Engineers, Fertilizer Chemistry, Organic Chemistry, Pharmaceutical Chemistry, Physical and Inorganic Chemistry and the Chemistry of India Rubber, held meetings in rooms especially assigned to them.

Some 500 were present at the "smoker" on Wednesday evening, which was fully up to the standard of the well-known smokers of the Chemical Society.

On Thursday evening Alexander Smith, president of the society, delivered his presidential address, entitled "An Early Physical Chemist," and was followed by an interesting lecture by Frank B. Kenrick and H. E. Howe, consisting chiefly of illustrations by means of the lantern of the effect of temperature, pressure, concentration, surface tension, osmotic pressure, etc., on reactions in heterogeneous systems.

A feature of the divisional meetings was the

Symposium on Mineral Wastes and their Conservation, held before the Division of Industrial Chemists and Chemical Engineers on Friday. The following papers were presented and the discussion was prolonged throughout the day:

J. A. Holmes: Carbon Waste.

W. H. Bassett: (a) Zinc Losses in Brass Manufacture; (b) Need of Special Alloys for Special Uses.

W. R. Whitney: New Uses to Reduce Abuses in Conservation.

A. V. Bleininger: Wastes in the Ceramic Industry.

A. D. Little: The Abuse of Brand.

F. K. Cameron: Waste and Conservation of Potash and Phosphoric Acid.

F. G. Cottrell: Sulphur Fumes and Flue Dust.

Charles L. Parsons: Miscellaneous Mineral Wastes.

This program, together with the papers given, will be featured in the March *Journal of Industrial and Engineering Chemistry*.

The Division of Pharmaceutical Chemistry held a Symposium on Drug Assaying on Friday morning and on Friday afternoon a joint meeting of the Society of Biological Chemists was held with the biological chemists of the American Chemical Society.

The secretary's report showed an increase of members of over five hundred for the year, the society's membership standing on December 1 at 5,603. During the year the society spent over \$55,000 on its journals, returning to each paid member in actual cost of publications more than 100 per cent. of his dues.

At the meeting of the council on Tuesday afternoon and evening the Biological Section of the society was authorized to form a Biochemical Division, electing its own officers, and two new local sections were formed; one at Detroit and one at New Haven.

Interesting reports were received from the Committee on Standard Methods of Analysis and from the Committee on Patent and Related Legislation.

It was voted to donate the library of the American Chemical Society to the New York Chemists' Club on condition that members of the Society have ready access thereto.

The question of the time of the annual meetings of the society was vigorously discussed, many members favoring a change from the winter season to Easter week, and a committee was appointed to take this into consideration and report to the council.

The election of the following officers was announced for 1912:

A. D. Little, President; C. L. Parsons, Secretary; A. P. Hallock, Treasurer; W. A. Noyes, Editor of the *Journal of the American Chemical Society*; A. M. Patterson, Editor of *Chemical Abstracts*; M. C. Whitaker, Editor of the *Journal of Industrial and Engineering Chemistry*; E. G. Love and Alexander Smith, Directors for two years; S. W. Parr, W. H. Walker, W. L. Miller and W. D. Bigelow, Councilors-at-Large for three years; C. H. Herty, Councilor-at-Large to fill the unexpired term of A. D. Little; E. G. Love, G. C. Stone and A. E. Hill, Finance Committee; Wm. McMurtrie, C. L. Parsons and B. E. Curry, Membership Committee.

Over two hundred and fifty papers were presented at the meeting, abstracts of many of which will appear shortly in *SCIENCE*.

CHARLES L. PARSONS,
Secretary

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE third annual meeting of the American Phytopathological Society was held in Washington, D. C., December 27-29, 1911, in affiliation with the American Association for the Advancement of Science. A program of fifty-one papers was presented. Joint sessions with Section G and also with the Botanical Society of America were held. The present membership is about 240. The report of the business manager of *Phytopathology*, the official organ of the society, showed a small balance to the credit of the journal after all the expenses for the first volume had been paid. The present editorial staff and business manager of the journal were continued for the coming year. The following are the officers for 1912:

President—G. P. Clinton, Agricultural Experiment Station, New Haven, Conn.

Vice-president—F. C. Stewart, New York Agricultural Experiment Station, Geneva, N. Y.

Secretary-Treasurer—C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

Councilors—W. A. Orton, U. S. Department of Agriculture, Washington, D. C.; Erwin F. Smith, U. S. Department of Agriculture, Washington, D. C.; A. D. Selby (*ex officio*), Ohio Agricultural Experiment Station, Wooster, Ohio; L. R. Jones (*ex officio*), University of Wisconsin, Madison, Wis.

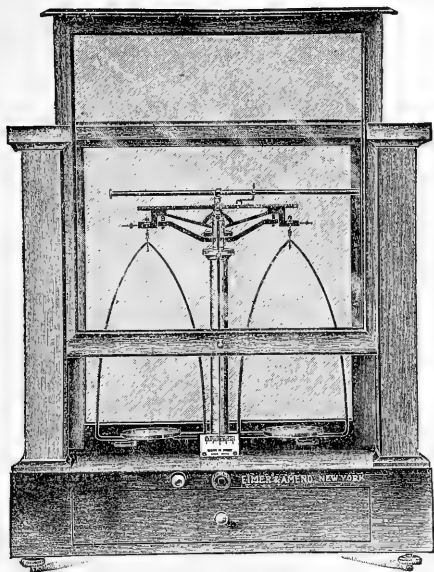
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THE STATUS AND FUTURE OF THE AMERICAN AGRONOMIST¹

On the occasion of this fourth annual meeting of the American Society of Agronomy it is of interest to note that our membership has now grown to more than two hundred and that our published proceedings are finding their place not only in the private libraries of American agronomists, but also on the shelves of the libraries of the leading colleges and universities of the country. Indeed the time seems to have arrived when this society should seriously consider supporting a journal. We have definitely put our hands to the plow. It behooves us, therefore, to be diligent, to push this society into the front rank of the scientific societies of the land, and to guard jealously against any and all influences which may interfere with the highest development of its individual members and thereby restrict its opportunity for public usefulness.

It must be recognized that no scientific body can be brought to its highest plane nor be made of the greatest service to our American people unless the ideals of its individual members are high. The future of agronomy in this country is, however, not only dependent upon such ideals, but also, in a very great degree, upon the administrative attitude of the institutions which we serve.

To the professor who, a generation ago, was covering in his way the whole range of agricultural science, the field of the present-day agronomist may seem narrow; but those who have kept pace with the march

¹ Presidential address before the American Society of Agronomy, November 13, 1911.

of recent events must be impressed with its breadth and by the fact that even greater specialization is foreshadowed in the near future, when the subject of agronomy may readily resolve itself into several distinct fields of effort.

The student of farm crops can no longer be content with a knowledge of what belongs to the art of crop production, but must now be well grounded in systematic botany, especially in its relation to the bacteria and fungi, and to the plant families which embrace the weeds, grasses and the common farm crops. He should understand and follow the work in breeding which is being done throughout the world.

In order to deal with many of the problems with which he will be confronted as an investigator and which he should be able to fully grasp as a teacher, fundamental training in physiological botany becomes essential. Indeed, this is only the beginning, for the agronomist has not only to deal in detail with the plants which contribute directly to the food supply of man and of our domestic animals, but also with an extensive soil flora almost undreamed of a half century ago, upon the study and control of which, for the furtherance of agriculture, the world is to-day barely entering. The agronomist of the future must not only deal with the effect of these soil plants upon each other and upon the higher plants in their parasitical and symbiotic relations, but also as producers of ammonia and nitrates, and as destroyers of compounds of sulfur and of nitrogen within the soil.

As suggested by the recent investigations of soil amebæ by Hall and his co-workers at Rothamsted, he must also deal with microscopic animal denizens of the soil which may militate against, or, as perhaps may yet be found, aid in the growth of certain beneficial fungi, and other micro-

scopic flora. In fact, the end is not yet, for chemistry now plays its rôle in furnishing the agronomist carbon bisulfide, and other substances for combating unfavorable animal life in the soil. Chemistry also plays its part in controlling and regulating the chemical reaction, and hence the dominance or decadence of various types or even of individual representatives of the soil flora.

There is reason to believe that we are to-day but entering upon the study of the organisms and of the conditions best suited to ensure the assimilation of atmospheric nitrogen by non-symbiotic means.

The whole question of the use of fertilizers and of their action is daily becoming more complex. It was a simple proposition when one supposed that it was merely essential to learn what elements crops removed from the soil and then to supply a proper part thereof, without special reference to the particular compounds used to supply them. To-day, cognizance must be taken of the effect of the associated compounds. The sulfuric acid and chlorin combined with ammonia in ammonium sulfate and ammonium chlorid may have a highly toxic effect from the outset, or such effects may soon develop in certain soils if care is not taken to maintain a proper basic condition. The subsequent effect of organic nitrogenous manures is quite different on some soils from that of nitrate of soda. Even though the avoidance of chlorin and sulfuric acid, when combined with ammonia, is of vital importance under certain circumstances, it is often less necessary under the same conditions if they are in combination with potassium, calcium and magnesium. For still other crops, or on another soil, they may nevertheless be used with good effect.

Another illustration is afforded by nitrate of soda. The residual effect of re-

peated annual applications may result in the most marked soil improvement, rendering successful the cultivation of a whole series of crops where they could not be grown successively before. The same treatment, even for a long series of years, may still fail to correct the existing soil conditions enough for other groups of plants. The continued use of nitrate of soda on another soil may cause it to become puddled until it is rendered practically unfit to be a habitat for most agricultural plants. For certain plants, such as the radish and beet, the residual sodium from nitrate of soda may perform valuable physiological functions which would be lacking, or of slight importance, in connection with certain other plants. Raw rock phosphate may be valuable as a fertilizer on the black soils of the Illinois corn-belt and for crops usually grown there, but for the light sandy soils of the Atlantic coast and for certain trucking crops its use at prevailing prices could perhaps not be recommended. To add to this complexity certain text-books proscribe the use of lime with superphosphates, or on soils where undissolved phosphates are to be used, and yet there may be soils on which liming is essential to the most economical use of each. It is, in fact, not enough that the agronomist should bear in mind and master all of these details, but now he is called upon to consider the specific requirements for lime and other substances, of hundreds of varieties of plants. He must also consider the alleged toxic root excreta and methods for rendering them innocuous, and he must take cognizance of the catalytic action of manganese and other elements not heretofore grouped in the galaxy of fertilizers and soil amendments. He must now consider the effect of legumes and other plants upon those growing in association with them and the effect

of given crops upon those which follow. The whole question of maintaining conditions favorable to nitrification is of prime importance in certain sections of the United States, and in this connection chemistry is again the handmaid of agronomy; yet in certain of the semi-arid regions of the middle west excessive nitrification is said to have become a scourge which is wiping out many of the most promising orchard industries. It must be evident that the agronomist must therefore be something of a climatologist, for in certain of these features the weather conditions are the chief governing factors.

The successful agronomist must also deal effectively with a host of plant parasites which may attack the roots, the base of the stems, or the other aerial parts of the plants. Some of these may be killed by poisons, whereas others can not. Even the sucking and boring insects furnish a problem in themselves, long after the entomologist has determined the essential features of their life history. Just as "every animal has its fleas and these have fleas to bite 'em," so the plants have their many animal and fungus parasites, with which the agronomist is forced to deal.

Since the soil is one of the chief concerns of the agronomist, and it is known to be teeming with many forms of microscopic life of beneficial or injurious character, it is important to take cognizance of the possible effect upon this life of the various kinds of organic matter and of fertilizers which may be introduced into the soil from time to time.

Notwithstanding the recent assertion that practically the same minerals are found in all soils, that plants feed from very weak solutions, and that the soil solution is being continually renewed, we cannot complacently fold our arms and watch the workings of the divine providence in

the production of food for the human race; for some soils appear still to lack enough available plant food at certain stages of growth, and others give rise to conditions, naturally, which require chemical and physical amelioration. It is an incontrovertible fact that soils derived from given kinds of rocks have usually distinct needs, whereas such treatment may be wholly neglected in the case of soils derived from rocks of a different character. For these and other obvious reasons the agronomist, in order to be well equipped to meet situations which may arise in another state, or in a new position to which he may be called, will find it of distinct aid if his fundamental educational equipment includes geology, mineralogy and physics in its special application to the many problems of the soil.

The agronomist will be brought face to face with emergencies and questions involving physical chemistry, the foundation for which is supplied not only by general chemistry, but also by knowledge of mathematics involving the calculus.

Finally, above and before all should be placed the subject of English, the call for which in some station bulletins is obvious, and in the use of which none can be too proficient.

It may be argued that the fundamental educational requirements as presented encroach upon other domains of science, that they are too comprehensive and are more exacting than the conditions demand. Nevertheless our progress as agronomists can not attain its maximum by depending wholly upon men who are trained only in a narrow specialty. Those engaged in given lines of agronomical research must have a sufficiently broad training in order to grasp the significance and bearing of factors lying frequently much outside of their strict domain. Had not Hellriegel

possessed an outlook broader than that circumscribed by the mere limits of chemistry, it is problematical if the discovery of nitrogen assimilation through the intervention of microorganisms might not have remained a problem for ourselves.

It is not enough that the teacher or investigator in agronomy be skilled in its art, but he must be trained in all of the natural sciences which are closely related to crops, fertilizers, soil amendments and to soils themselves in all of their several relations. The man who looks forward to service in the west or middle west can not neglect the chemistry of fertilizers in their relation to the special crop and to the special soil, for the fertilizer problem is advancing westward at a rapid rate and many of the present-day needs of the east will, in the near future, become the needs of much of the west and middle west.

From what has been said it must be obvious that the ordinary college course can not be considered an adequate preparation for the life work of the agronomist, whether he be engaged in teaching or in research, but that this must be supplemented by at least three years' work at the university. Conversely, it must be equally obvious that he who would succeed in the fullest degree in his scientific achievements in the domain of agronomy must also be familiar with the subject as an art, and if this knowledge was not acquired at home on the farm, before the beginning of the college course, it should surely be made a part of his equipment before entering upon the university course.

The demands of the times make imperative not only a knowledge of the art of agronomy and the possession of the foundation contributed by the college and university, but they demand that the teacher or investigator keep continually in touch with the work of others in this and other

countries, and to this end a reading knowledge of French and German, and if possible of other foreign languages, is essential. The argument that it is sufficient to merely read the abstracts of papers is specious. The investigator should never be content with anything short of the original, since ideas as to the relative importance of the different parts of an investigation are often widely variable, dependent upon the outlook or particular experience of the abstractor. It, therefore, not infrequently happens that a point which may be passed over as insignificant is vital to the work of some investigator, who, if confined solely to consulting the abstract, might never be able to profit by it.

It is obvious that the teacher must have sufficient time at command for daily recreation if he expects to maintain himself in condition to present his subject matter year after year to his classes in a clear and forceful manner. The same thing is necessary for the investigator in order that he may be keen and alert in the pursuit of his problems. He is then in condition to recognize points of attack which the man pressed and wearied with many duties might pass by unnoticed. To him who would be a strong, full man, capable of imparting inspiration to his students or of attacking problems of research with the true enthusiasm which is essential to success, time must not only be allowed for renewal of physical strength and for abundant reading, but *also for undisturbed and consecutive thought*. This means that no institution can long expect to be a leader in the field of education or in research, if its policy is to demand so much by way of other duties or so many hours of teaching that its employees can become leaders neither in thought nor in research in their chosen specialties. A university president, in a recent address, announced that those

teaching at his institution were hereafter to be measured for their fitness by their output in research. Such a policy, while prompted by a commendable spirit, might be more nearly applicable in a new institution in which the teaching demands are reasonable, but it is likely to work the grossest injustice if applied immediately in a college where worthy professors have grown old in a treadmill of exacting service, which has left no time for gathering inspiration nor for work of research. Such men, if given the opportunity at the right time, might have won a national or world-wide reputation as investigators, for they may have been original, diligent and fired with an enthusiasm which the institution itself gradually smothered and snuffed out. Such men should not be cast aside like an exhausted sponge, for the institution and the state owe them a debt which they can not repay. Again, a college professor can not always do his best work if made to feel that his tenure of office depends upon his yearly output in research. Such avowed watchfulness by a president or by a committee on efficiency is likely to lead to superficiality, to hasty publication, or to create unrest disastrous to research of a high order and to bring many disastrous consequences in its train.

Object lessons of spoiled investigators are especially common, in many of the smaller colleges, and even in many of the larger ones; yet the time may never come when it will be safe to measure the fitness of all men for college teaching solely, or even chiefly, by their research output. Nevertheless, one can not but recognize the desirability of encouraging teachers to practise exhaustive reading on special subjects, or to undertake special advanced research, whenever the demands of their positions and the attendant circumstances render it possible.

From what has been said it would appear that all teachers, and those who are selected to conduct research, should have at least three years of university training superimposed upon the college foundation. In saying this the writer recognizes that some of the best men in the country have not had this experience, but yet have won an enviable reputation in their respective lines, even in certain cases outstripping many who have enjoyed a more extensive fundamental training. It must, nevertheless, be recognized that such men have succeeded not in consequence of their handicap, but in spite of it! They were close observers, diligent students, and were possessed of original and judicial minds.

Admitting that the university training is a great desideratum in all cases, the problem presents itself of lending sufficient encouragement to young men so that they will be willing to devote three of the best years of their lives, and a large sum of money, to university study.

At almost every session of the Association of American Agricultural Colleges and Experiment Stations some college or university president or station director has bemoaned the difficulty of finding adequately trained men to fill the higher positions, especially in research. Indeed, the Secretary of Agriculture, the Hon. James Wilson, has repeatedly stated in public addresses that the Department of Agriculture finds it impossible to secure in this country men adequately qualified for many of the positions in the federal service, on which account his department is forced to train its own men. This leads to the query: Why does not the same principle of supply and demand hold as in lines of industry? It is a fact, which I think will be disputed by none who are well informed, that this country furnishes exceptional opportunities to-day for the young man just out of

college. Perhaps, indeed, if some of them, like men known to the writer, were forced to begin, after completing a four-year college course, at a salary of from \$16 to \$20 per month, all of which was required for board and clothes, they might be willing to make greater sacrifices than at present in order to insure for themselves a future, by securing a university training at whatever cost. To-day, however, the young graduate can readily command an initial salary of from \$800 to \$1,200, and many have been advanced within from two to three years to salaries as great as, or greater than, those paid in other reputable colleges to much older and more experienced men who have enjoyed a university training.

When these young men look about them in the institutions with which they are connected they may even find others at the heads of departments who have never enjoyed graduate study. They may also find those who, have made the sacrifice, struggling by all sorts of means to add enough to their insufficient incomes to enable them to support a small family, with few comforts, no luxuries, and even with deprivation and need before them, in case of unusual illness or misfortune. It is no wonder, under such circumstances, that he thinks "a bird in the hand is worth two in the bush" and prefers to go on accumulating, rather than to spend three years' time and the savings of other years in order to secure the mere intellectual advantage of further study. As I have several times pointed out in public addresses, there can be no permanent remedy for such a condition short of an assured pension for those who have given ten to fifteen years of efficient, faithful service to such colleges and stations, or there must be occasional half-year intervals of freedom and a marked and progressive increase in compensation for the older and experi-

enced men. As concerns pensions, one that does not become assured until the end of a thirty-year period of service, while a great boon to those who finally receive it and a welcome aid to the president in unloading undesired or superannuated professors, nevertheless fails to furnish that assurance of security in case of disability or later financial difficulties which encourages the professor to satisfactorily equip his library, to travel, to study and to surround himself by the broadening influences which are essential to his greatest intellectual development and to his greatest usefulness to the students who come under his instruction. In this matter of pensions and conditions surrounding them we have a valuable lesson to learn from Germany.

It has been argued by some that the early assurance of a pension robs the prospective recipient of initiative and enthusiasm in his chosen profession and encourages a letting up of his intellectual activities. To such as advance this argument the writer begs to enter an emphatic denial of the justness of the accusation, for from his personal acquaintance with professors in many of the leading German universities and his observation of their spirit of research, he is convinced of the utter incorrectness of such a position. Indeed, nowhere in the world could one find greater devotion to duty, greater willingness to make personal sacrifices, or greater zeal in investigation, than among the professors of these German universities, who can look forward complacently to the future if disabled, and in any event with the comfort and knowledge that their families, after their work is done, will be cared for properly as a reward for a lifetime of faithful public service.

Finally, this society will do well to encourage the development in our universities of higher and broader graduate courses

in the applied sciences related to agriculture. Let us use our influence as a body to secure from the Carnegie Foundation, for the teacher and investigator in the smaller land-grant colleges, the same fair and just recognition for quality and amount of public service rendered as is accorded to the teacher of mathematics or of the classics in the older classical colleges of the country. If necessary, let the American Society of Agronomy urge upon congress the provision of a pension system for the land-grant college, based upon a reasonable probationary limit of service as a condition for its becoming assured. If to this these colleges will add the sabbatical year, or will allow a full half-year in every five, and will give adequate and progressive advances in salary with the years of service, we shall soon see plenty of young men fitting themselves well for the work of teaching and research.

In closing I would not fail to emphasize that young men entering our profession should do so with the missionary spirit and with the desire to serve their fellows uppermost in mind, but the situation to-day is such that many who set out with courage are forced, out of justice to their families and through failure to secure the reasonable comforts and necessities of life, to seek, against their will, such financial returns in other callings as are rarely the reward of the agricultural teacher and investigator.

H. J. WHEELER

*THE INTRODUCTION OF PHYSICAL CHEMICAL CONCEPTIONS IN THE EARLY STAGES OF THE TEACHING OF CHEMISTRY*¹

THE question I have been asked to discuss is not a new one, but is, in my opinion, one of fundamental importance. Whenever any

¹ Paper read before the American Chemical Society in Washington, December 27, 1911.

great advance has been made in any branch of science, the question has arisen how early should this be incorporated in the teaching of that science; in a word, how closely teaching should follow research, and various answers have been given.

That we are dealing here with a fundamental question is obvious after a moment's reflection. Shall we teach the beginner, in a judicious way, of course, the science as it is at the time in question, or shall we teach him what is not only hopelessly out of date, but what is known to be absolutely untrue?

In answering this question we must take into account that the beginner of to-day is the advanced student of to-morrow, and the chemist of the near future. It is true that most of the beginners in any branch of science never pursue that science at any length, and to these perhaps the least harm is done by teaching the science in an out of date manner; but the question becomes more serious when we are dealing with those who propose to devote their lives to the branch of science in question.

Why has the question that we are discussing arisen at this time? As is well known, it has come to the front as the result of certain fundamental discoveries made in chemistry towards the later part of the last century. These are usually known as *physical-chemical generalizations*, because they were reached through the application of physical methods to chemical problems.

I think the term "physical-chemical" is unfortunate, because it may leave the impression that we are dealing here with something different from chemical, while, in fact, we are not. Indeed, I think the term "physical chemistry" is unfortunate, since it may lead to the conclusion that here is something that is not chemistry, while it is simply an integral part of chemistry. I greatly prefer the term "general chemistry" or "generalized chemistry"; since the generalizations which have been reached in this field concern most vitally and fundamentally the whole science of chemistry. This same thought is echoed in the title of Ostwald's great work, "Lehr-

buch der allgemeinen Chemie." The term "physical chemistry" is, however, so widely disseminated, and the leading journals in this field in German and French both bear this title, so that the hope of reform in this nomenclature seems remote.

The generalizations that we have in mind are: The discovery of the Law of Mass Action, by the Norwegian physicist, Guldberg, and the Norwegian chemist, his son-in-law, Waage, in 1867; the discovery in 1886 of the applicability of the laws of gas-pressure to the osmotic pressure of dilute solutions of non-electrolytes, by one of the greatest men of science who has ever lived, Van't Hoff; and the explanation by Arrhenius in the same year, of the apparent discrepancies presented by electrolytes, *i. e.*, the announcement of the theory of electrolytic dissociation; of less importance perhaps is the interpretation of chemical valence in terms of Faraday's law, but scarcely so, at least from the pedagogical standpoint; and finally, the discovery of the electron, by Sir J. J. Thomson, and the instability of the chemical atom, by Rutherford.

The question then is, shall these generalizations be taken into account in the early stages of the teaching of chemistry, or shall they not? I know of no productive chemist who doubts the value of introducing them into more advanced stages of work. To do so would be to teach and learn a science of chemistry, with the science all left out.

A fair way to judge of the value of any discovery is to imagine that it had not been made, and see how the science would be affected by its absence. Similarly, in dealing with a question like the one under discussion, it would seem to me that a logical way to approach it would be to ask, What is lost by not incorporating the modern advances into elementary chemistry, and then what is gained by doing so?

It is certainly true that if we omit these generalizations from the early stages of chemical work we are teaching something that is out of date. There can be no two opinions on this point. But this alone does not solve our problem.

Perhaps the science as developed twenty-five years ago is better adapted to teaching the beginner than is the chemistry of to-day. It is certainly simpler. Why not teach the first year student in chemistry, in addition to a judicious number of the empirical facts of the science, something about the atom and the molecule, and leave it for a later stage to present the more recent developments? What would be lost by so doing? We have now arrived at a fundamental question.

The answer to this question is, in my opinion, that we must no longer teach the chemistry of three or four decades ago, because we know that in many fundamental points *it is untrue*. But it might be answered, we grant you this, but for the sake of *simplicity* we will teach the old chemistry, for, say a year, and then turn the student over to the new.

It is right here that an insuperable difficulty is encountered. It is the *persistence of first impressions*. Any one who has observed this at all carefully knows how nearly impossible it is to correct erroneous first impressions. Whatever the physiological or psychological explanation of the persistence of these impressions may be, the fact remains.

I have had this brought home to me so often and in such a forcible manner that it has made a deep and lasting impression. It has been my lot to try to teach something of the newer developments in chemistry to some students who have been trained in the older school. The result has been that it has required years of incessant drilling to ingraft the new generalizations into the mind of such a student. At first, the newer conceptions were scarcely more than tongue deep. In answer to questions it would be stated at first that "it is said" that such and such is true, or "the book says," or "you said" that this or that is the explanation; all of which went to show that the new ideas had penetrated hardly more than skin deep, and this, notwithstanding a serious effort on the part of an honest student to make the real science of chemistry an integral part of himself.

What is the explanation of this rather distressing condition of things? *Erroneous first*

impressions, from which it is almost impossible wholly to escape.

There is one other matter to which I should like to refer before leaving this part of the discussion. This is the tendency which has existed in the past in this country to make chemistry *easy*. I do not believe there can be much difference of opinion as to this being a fact. How often and how justly have we heard the elementary course in chemistry branded by the student body as a "snap"; and for this very reason a preponderating number of students elect this course.

This condition is nothing less than *fatal*, as far as the science of chemistry is concerned; and every serious teacher must study its cause and apply the remedy.

How has this condition come about? Largely, I believe, as follows: A quarter of a century ago chemistry was almost wholly an empirical branch of science. Rowland used to say that chemistry in his day was in the same stage of development as physics in the days of Michael Faraday; and this was only a slightly exaggerated statement. It was necessary at that time to present the subject of chemistry largely by the empirical method. The result was with chemistry, as with any other empirical branch of science, the comprehension of the subject involved primarily, and may I say chiefly, the memory. A reasonably developed memory is much more general than equally well developed reasoning powers, and the use of the latter involves the expenditure of far more mental energy than the use of the former. This is the reason why chemistry was regarded as *easy*. It was something that could be readily memorized.

While this was perhaps a more or less necessary condition, several decades ago, those conditions are now largely changed. Chemistry is rapidly advancing along the way to become a branch of exact science, and it can be dealt with to-day in no small measure by the deductive method.

Far be it from my purpose to make chemistry *hard*, or even harder than is necessary for the best good of the science, at least in the early stages of the study of the subject; but a

far more important object than to make chemistry easy is to make it scientific. The object of the teacher should be to make the subject *clear*, but I have not very much respect for making things easy, since in science whatever is *easy* is *superficial*. There is no inherent reason why we should make elementary chemistry appreciably easier for the average student than elementary physics; that is to say, make it more superficial.

The argument against introducing the newer generalizations into the elementary teaching of chemistry, based upon the fact that their omission renders the subject easier, is, then, in reality a strong argument in favor of incorporating them.

The question as to whether it is easier for the teacher to introduce or omit the newer conceptions does not enter into the present discussion, since every efficient teacher is abreast with the development of his science; and furthermore, in matters of teaching, it is only the best good of the student that is to be considered.

Let us now turn to the other question: What is *gained* by teaching elementary chemistry from the standpoint of the newer generalizations?

A beginner in chemistry soon learns that when a chloride is treated with concentrated sulphuric acid, hydrochloric acid gas escapes, and the chloride is transformed into the corresponding sulphate. At one time this was explained as due to the greater *strength* of sulphuric acid; but we can not offer this explanation any longer, since we now know that sulphuric acid is only a little more than half as strong as hydrochloric.

The same beginner quickly learns that when a solution of a chloride is treated with a solution of silver nitrate, insoluble silver chloride is precipitated.

These two classes of phenomena are typical of a large number of chemical reactions. In the past such facts were summarized by saying that whenever a gas can be formed it is formed, and whenever a solid can be formed it is formed. This was simply *renaming* the phenomena in question, but of course explained

nothing. Yet it was the best that could be done at that time.

It is a very simple matter to give any one, and therefore a beginner in chemistry, some qualitative conception of the effect of mass or quantity on chemical reactions—chemical reactions being dependent upon two things, the nature of the substances brought together, and their relative quantities. If the beginner can grasp one of these conceptions he can grasp the other.

Given the conception of mass and even qualitatively its function in chemistry, the two typical reactions mentioned above can be interpreted or, indeed, explained.

Hydrochloric acid having a low boiling point is a gas at ordinary temperatures, and escapes from the field of action almost as rapidly as it is formed; its active mass being thus reduced nearly to zero.

The silver chloride formed is nearly insoluble in water. It is precipitated as a solid and its active mass is thus small. I think this treatment renders the two typical reactions more clearly understood, and is more scientific than simply renaming the phenomena.

I venture to predict that not a few students of chemistry, not only of one year's standing but of several, are without any adequate conception of the importance of that condition in which matter in a given state of aggregation is, when mixed with matter in the same or a different state of aggregation—in a word, of the importance of *solution*.

If they were told that the whole science of chemistry is a branch of the science of solutions, they would either not understand the statement at all, or would regard it as a gross exaggeration.

It is a simple matter to make this reasonably clear, at least towards the end of the first year's work in chemistry. By that time enough reactions have been studied to show the student that practically all, if not all chemical reactions take place in solution, using the term solution in the broad sense in which it is employed to-day. Matter in the pure homogeneous condition is scarcely

capable of doing anything chemically, and that the science of solutions is much broader than chemistry will be seen after a moment's reflection. Geology is largely a science of solutions—of aqueous solutions and molten magmas, and how many branches of the biological sciences owe their existence to matter dissolved in other forms of matter?

In the pure homogeneous condition matter is, as we have stated, relatively inert. Nature, and, consequently, the science of nature, is, as it is, primarily due to matter in the dissolved state; and our knowledge of solutions, thanks to Van't Hoff and Arrhenius, is now reasonably satisfactory. We know far more about matter in the gaseous state than in the liquid or solid state. Van't Hoff has shown us that we can deal with solutions in many fundamental respects as we deal with gases. Consequently, we know far more about matter in solution than in the pure homogeneous liquid or solid condition. Why should these facts be concealed from the student of chemistry until late in life?

And now we come to another fundamental matter—the nature of the units that take part in chemical reaction. For a long time it was taught that the atoms and the molecules are the active chemical agents, and this was in keeping with what was known at the time.

This is now largely changed. The number of concordant lines of evidence which show that electrically charged parts are necessary for chemical activity, is so great, that I know of no productive chemist to-day who seriously questions it. After thinking over this problem and working upon it for a good many years, I am of the opinion that there is no chemical reaction known to man in which at least one of the substances taking part in the reaction is not more or less ionized. Indeed, I am unable to form any physical conception of even the possibility of a chemical reaction between electrically neutral parts, any more than I can form a conception of two electrically neutral bodies attracting or repelling one another electrically. It would lead us much too far to discuss at all fully this question here, nor is it necessary to do so.

To furnish evidence to-day for the general truth of the theory of electrolytic dissociation, would be as unwise and as useless as to furnish new evidence for the law of the conservation of energy, or for the law of the conservation of mass.

In the light of these facts are we justified in continuing to teach the beginner the old chemistry of atoms and molecules, which we know, or should know, is untrue; trusting to later years, to new experiences, or to another instructor to correct these erroneous first impressions, which, as has been stated, is well nigh impossible.

Take another phase of things. A phenomenon which must be encountered very early in the study of chemistry is *precipitation*, already referred to in another connection. Has it been possible to treat this subject scientifically until quite recently? I think not. Whenever a precipitate could be formed it was formed, was about the way this matter was left. In the chemical reaction in question a solid is formed, which is practically insoluble in the solvent used; and being insoluble it is thrown down in that coarse-grained condition that we call a precipitate.

Think of this for a moment. When the solid was formed it was probably in a state of molecular aggregation. How do these solid molecules know enough to come together and form aggregates of the sizes that exist in precipitates? Furthermore, if this is the "natural condition" of insoluble solids when formed in a chemical reaction, then why do we not *always* have precipitation when an insoluble solid is formed in a reaction? In a word, why do we have in some cases *colloidal suspensions*?

To fix the idea and by way of illustration, why is arsenic sulphide precipitated when arsenic chloride is treated with hydrogen sulphide, but is not precipitated when arsenic oxide of the same concentration as the chloride is treated with hydrogen sulphide? Not only must every teacher of chemistry have asked himself this question, but every intelligent student, before he has advanced very far, must do so.

This is now very satisfactorily explained by another really great man of science—a man whose work for chemistry is quite as fundamental as his work for physics—I refer, of course, to Sir J. J. Thomson.

He has shown that whether or not precipitates are formed is dependent upon the presence or absence of appreciable numbers of charged parts or ions. Arsenic sulphide is precipitated from the solution of the chloride because the hydrochloric acid set free by the action of the hydrogen sulphide is strongly ionized. On the other hand, arsenic sulphide is *not* precipitated from the solution of the oxide, because no strongly dissociated substance is formed as the result of the reaction, and neither arsenic oxide nor hydrogen sulphide is strongly dissociated.

But Thomson does not stop with showing that ions or charged parts are necessary for precipitation. It was shown by Burton, working in Thomson's laboratory, why, or at least how, this is the case. Space will not allow me to go into this in detail. Suffice it to say here that the colloiddally suspended particles are charged electrically, and for any given colloid all of the particles are charged with the same sign. These electrical repulsions work counter to surface-tension, which acts so as to draw the particles into the smallest surface for a given mass—to draw the colloiddally suspended particles into lumps as in an ordinary precipitate. When ions are present these electrically neutralize the charges upon the colloiddal particles and allow surface-tension to produce its full effect.

That ions are necessary and sufficient to effect precipitation, can readily be shown by adding almost any electrolyte to the colloiddally suspended particles of arsenic sulphide, obtained by treating the oxide with hydrogen sulphide. A precipitate is formed at once.

This work places the whole subject of precipitation, for the first time, upon a scientific basis, and while it can not be presented fully to a beginner, I see no reason why it should not be judiciously taught to a student in his second year of chemistry, *i. e.*, when he is

studying qualitative and quantitative analysis.

Then arise some of the most fundamental problems. What is a chemical atom? If made up of parts what are these parts, and how are they arranged within the atom? How does one chemical atom differ from another chemical atom? Are the chemical atoms stable?

These matters must all be taught the student of chemistry and the question is when? They can not of course all be presented fully to what we ordinarily mean by a beginner, but I can see no reason why they can not be presented, in an elementary manner of course, at the proper places, even in the first year's work in chemistry, unless we are wedded to the dogma that chemistry must be made *easy* in order that it may be *popular*.

We can certainly no longer teach that the chemical atom is an "ultimate unit" in the light of the recent work of Thomson. We know that it is made up of parts, and furthermore, we have some idea how these parts are arranged in two dimensions in space in a section through the atom. We have very good reason to believe that most, if not all of the differences between the atoms of the various chemical elements are a function of the number, arrangement, and possibly the velocities of the electrons composing the atoms. And why not, in a common-sense manner, tell the student of chemistry so, even in the comparatively early stages of his work?

Indeed, I think it is far simpler to teach this fundamental connection between the elements, than to have the beginner look upon the eighty or more elementary substances as so many discrete, disconnected, and fundamentally unrelated kinds of matter—to say nothing of it being true; and in the teaching of science I think *truth* is even more important than *simplicity*.

And again, take the question of the *stability* of the chemical atom. The stable atom of the past is now hardly more than historically interesting. The work of the Curies and especially of Rutherford, on radioactive sub-

stances, has placed this almost beyond the pale of doubt. The atoms with the largest atomic masses are certainly unstable, and it is highly probable that the atoms of all the elements are undergoing devolutionary changes.

In the light of these facts are we going to persist in teaching the stable atom, without qualification even to the beginner, and rely upon time, fate or the effort of some one else to correct, if possible, the evil that we have done? It is perfectly true that the stable atom is simpler for the beginner than the unstable atom, but here again it is *simplicity vs. truth*.

In conclusion, there is one other matter which I can not leave untouched, because it lies at the very foundation of our science. I submit that no serious student of chemistry, and this is the class for which we must be most concerned, can study the subject for six months, learning that certain things react chemically with certain other things, and that certain things do not react with one another, without asking himself the question, why is this? Why do some substances react, and why do others not react? If this question is not raised by the student it certainly should be by the instructor. The question then is, why do chemical reactions take place at all?

We might almost call this the most fundamental question of chemical science. It is certainly so for the student, and that in the early part of his career. This brings me to the most heterodox position that I have yet ventured to take.

Should we not introduce into our elementary courses in chemistry something about the *energy changes* that take place in all chemical reactions, and which make those reactions possible? In the evolution of chemistry the material changes were studied first, and this was natural. These changes were the most obvious, and the material products were often desired for one purpose or another. Again, these material changes were the easiest to study, and chemists, like other men, were inclined to follow the lines of least resistance. I believe the nineteenth century will go down

in the history of chemistry primarily as the period of *material chemistry*.

But even this is changed now. Without decrying in the least the study of matter, the chemist of to-day insists that we can no longer ignore the changes in energy that manifest themselves in every chemical reaction. Indeed, he would even go further, and point out again that whatever is easiest in science is relatively most superficial.

We know to-day that *all* chemical reactions are really due to differences in the intensity, or quantity, or kind of the intrinsic energy present in the substances that are to react; and whether any two substances will or will not react is determined primarily by this difference. We can, furthermore, form a physical conception now of what is meant by intrinsic energy, since we have the electron theory of the atom; it is primarily the kinetic energy of the moving electrons within the atom.

But dare we venture even to refer to energy or energy changes in the early stages of the teaching of chemistry? I ask why not? The physicist does not hesitate to do so. Indeed, most of his subject has to deal very largely with changes in the different manifestations of energy. Why should we assume that the chemical student has less natural intelligence than the student of physics, especially when he is almost always the same student? (In my opinion no one should be allowed to begin the study of chemistry until he has had at least one year of physics.)

There is, of course, no reason for assuming that the beginning chemist is not as intelligent as the beginning physicist, and, therefore, there is no more reason why a student of chemistry should not deal with changes in energy than a student in physics, especially when these energy changes are as fundamental for chemical science as they are for physics.

Instead of teaching to-day that chemical reactions are *accompanied* by energy changes, why not teach the truth, which is, that it is these very energy changes that are the cause of all chemical reaction? Systems which alone are fairly stable, when brought together

may become unstable. There is a running down of a part of the intrinsic energy of one or both of the substances into heat, light or electricity but almost always largely into heat; and the substances rearrange themselves into those new combinations which are most stable under the new conditions.

This is what we ordinarily describe as a chemical reaction, and this can be taught to any sensible student just as well as the elements of physics can be taught to him.

Finally, the matters herein referred to, together with many others which time will not permit me even to mention, can not, of course, be taught the beginner all at once, in addition to the so-called material facts of chemistry. It is, however, a fair question to ask whether some of these matters would not be a fair substitute for a part of the pyrotechnics that sometimes adorns the chemical lecture table?

In all such matters the judgment and common sense of the teacher must of course be the final guide, and the intellectual fiber of the student must also be taken into account. It goes without saying that we must not teach dogmatically anything to the student of chemistry, much less to the beginner in chemistry, that is not reasonably substantiated; but I believe that all of the matters referred to above and many more of their type belong in this class.

The final question then is, shall we have two chemistries or one? Shall we have a chemistry of research, pushing forward at a pace that makes the last twenty-five years mark a distinctly new epoch in the history of the science? and another chemistry taught the beginner, which practically ignores all that has been done within that period; which deals not only with what is obsolete, but with what we know to be largely untrue, and which relies upon subsequent teaching to do almost the impossible, *i. e.*, correct erroneous first impressions, which must in some method be corrected, or the result is fatal?

Or shall we have one science of chemistry? Research leading the way, and teaching following fairly closely behind? At least doing

nothing that will have to be undone, but incorporating what is truest and best.

For those who believe as I do that the latter is the more scientific course, there is not only no ground for pessimism, but not even for pragmatic meliorism.

The progress in this direction during the last decade, not only in the better colleges and universities, but in the more progressive high schools, has been so rapid that there is room for nothing but the most cheerful optimism.

HARRY C. JONES

IS SCIENCE REALLY UNPOPULAR IN HIGH SCHOOLS?

THE period covered by the tenth decade of the nineteenth century and the first of the twentieth was one of great activity in the reconstruction of high school schedules. The reports of the N. E. A., Committees of Ten and on college entrance examinations, the formation of the College Entrance Examination Board, the Perry and other movements for the reform and unification of science and mathematical teaching, all must have influenced high school curricula, and the alterations of the curricula must have shown effects in the percentages of secondary students in the various courses.

The famous attack made by President G. Stanley Hall¹ on the methods and attitude of secondary teaching in the United States was based to a certain extent on the summary tables of the percentage of secondary students in the United States taking the various high school studies, and published in the reports of the Commissioner of Education, 1890 to 1907. In order to exhibit these I have plotted the data on a chart. The curves for studies, graduates and college preparatory students are from the summary table (p. 1052), Report of the Commissioner of Education for 1907; that for per cent. of secondary students

¹G. Stanley Hall, "How Far is the Present High School and Early College Training adapted to the Needs and Nature of Adolescents?" N. E. Asso. Coll. and Prep. Schs., 16, p. 72, 1901; *Ped. Sem.*, 9, p. 92, 1902; *Sch. Rev.*, 9, p. 649, 1901.

in the total population, from table on p. 1044. No curves are plotted for trigonometry and psychology, as they have never been of appreciable importance as high-school studies; the curves for Greek and geology are omitted, as they so nearly coincide with that for astronomy as to cause confusion.

Certain facts stand out from the curve-sheet. Greek has declined; so has civics; Latin, modern languages, English literature, rhetoric and foreign history have all increased, some of them enormously; *all the natural sciences* have fallen—geology, astronomy, chemistry, physics, physical geography and physiology have all dropped down, some of them enormously. Meanwhile the percentage of graduates has increased—a good showing, indicating that students are better satisfied with the schools than they were formerly—the proportion of students preparing for college has diminished, and the proportion of secondary students to total population has nearly doubled.

It is well known that the proportion of secondary students in the earlier years of the course is greater than that later. Hence a possible cause of an observed diminution in popularity of a subject is the alteration of schedules so as to shift the study into the later years of the course, and *vice versa* for an increase of popularity. Then the remarkable growth of the elective system, which occurred largely in the period covered by these curves, and the actual withdrawal of courses, are other causes which would affect the percentages. Now if we can in any way numerically express the opportunity which the average student has to take a given study, and compare with this the amount to which he takes advantage of his opportunity, as expressed in the tables of the bureau, we have in the ratio a numerical measure of the popularity of the study. I hope to be able to do this in a rough way from data already published, and to show that the drift away from science is in part at least the result of schedule tinkering, and does not completely express the taste of that much-criticized phenomenon, the rising generation.

If we can find the probability that a student selected at random from the mass shall be in any particular year of the high school course, and also the probability that a particular subject shall be offered by his school in that year, then the probability that this randomly selected student shall be taking this subject in this year is the product of these two probabilities, on the supposition that the subject is *required of all students* in this year. And this probability is also the percentage of students in the great mass who would be taking this subject in this year under the same supposition of no election.

The first probability is given by the Commissioner of Education in the Report for 1907, p. 1046, where it is said:

For several years this bureau has estimated the proportion of secondary students in each of the four years as 43 per cent. in the first year, 26 per cent. in the second year, 18 per cent. in the third year and 13 per cent. in the fourth year. This estimate was based upon the enrollment of secondary students by grades in the high schools of a number of cities.

Two things show that this is not a constant distribution. First, the bureau has for three or four recent years collected data of this sort for the whole country, beginning with this report of 1907, and the figures do vary a fraction of a per cent. from these estimates. Second, the percentages for high-school graduates charted on the curve-sheet, show that the proportion of graduates in the high-school population has gradually increased, being 10.05 per cent. in 1889-90 and 11.87 per cent. in 1905-6. But in spite of this evident, though not very large, variation, we have no other means of getting at the facts, and will use these mean values as representing the probability of a randomly selected student's being in any particular year of the course.

The means for estimating the amount and effect of schedule tinkering is very incomplete. An article by Professor E. G. Dexter²

² E. G. Dexter, *Sch. Rev.*, 14, p. 254, 1906; "Ten Years' Influence of the Report of the Committee of Ten."

gives the only statistics available for this purpose, so far as I know. He collected the printed programs of schools for the period just preceding 1894, when the report of the Committee of Ten would not yet be effective, and for that ten years later, and compared the two. In his own words:

For the earlier portion of the study 80 schools were covered: 35 in the eastern section of the country, 25 in the middle west and 10 each in the south and far west. For the period a decade later the number of schools was 160: 49 being in the east, 46 in the middle west, 30 in the south and 35 in the far west.

Neither these numbers nor the particular schools studied were the result of arbitrary choice, but in most cases of dire necessity. Every available course of study for the years 1892 to 1894 was considered, and this was essentially true for the period ten years later. So far as possible, the same schools were considered at both periods; but, as indicated by the figures, many more schools were included in the later than in the earlier study. This was that errors due to accidental conditions might be reduced to a minimum. I have not thought it necessary in this paper to give the names of the particular schools studied, but will say that the list includes the high schools of nearly all the larger cities of the country; and that none of the smallest schools are covered is suggested by the fact that only those issuing printed courses of study are included. The part of the study covered by this paper has to do only with those recommendations of the special subcommittees (of the Committee of Ten) which bear upon the high-school curriculum.

The second factor, the probability that the student will have the opportunity to take a study in the year in which he happens to be, can in most cases be computed from Dexter's data, in an approximate sort of way. I will give the computation for German in some detail, as in it appear all the irregularities which show themselves in connection with other subjects, and further, the resulting table contains the only essential absurdity which developed in the preliminary computations.

First, Dexter's table for German.

TABLE I

	1894	1904
Percentage of schools offering 2 years	34	25
Percentage of schools offering 3 years	33	36
Percentage of schools offering 4 years	33	23
Percentage beginning in the first high-school year or earlier	48	47
Percentage beginning in the second high-school year	30	41
Percentage beginning in the third high-school year	22	12
(I infer that 16 per cent. gave a 1-year course in 1904, beginning in year III.)		

This table I rearrange and extend as follows:

TABLE II

Begin	1894			Begin	1904		
	Per Cent.	Length	Per Cent.		Per Cent.	Length	Per Cent.
I.	48	33	4	I.	47	23	4
		15	3			24	3
II.	30	18	3	II.	41	12	3
		12	2			29	2
III.	22	22	34	III.	12	4	2
		0	1			16	1
IV.	0	0	0	IV.	0	0	16

The percentages opposite the half-braces ({} mean thus: For 1904 23 per cent. of the schools gave a 4-year course, while 47 per cent. began in year I.; hence 24 per cent. must begin a 3-year course in year I. Thirty-six per cent. gave a 3-year course, hence 12 per cent. begin the 3-year course in year II., etc. That this course of reasoning is imperfect appears from the fact that according to it — 4 per cent. begin a 2-year course in year III., which is absurd. However, the difficulty lies in the original data being out of reach, and as the absurdity is not going to be of great influence on the computations, as it comes in the third and fourth years, I use the figures as they stand. The table for German is the only one in which any patent absurdity shows itself.

From this table I obtain the percentages which express the random student's opportunity to take German, *i. e.*, the per cent. of students who would be taking German were it required wherever and whenever it is offered, thus:

The probability that a student be in the first year of the course is 0.43, from the data of the Bureau of Education; the probability that German will be offered in that year is (1904) 0.23 for a 4-year course and 0.24 for a 3-year course, or 0.47 for both; the desired probability is then $0.43 \times 0.47 = 0.202$.³ The probability that a student be in the second year is 0.26; the probability that German will be offered in that year is 0.29 for a 2-year course begun that year, 0.24 for a 3-year course begun in first year, 0.23 for a 4-year course, 0.12 for a 3-year course begun in second year. The resulting probability that a student be taking German, if it were a required study in second year, is $0.26 (0.29 + 0.24 + 0.23 + 0.12) = 0.232$. Similarly for the other years. Then the total probability that a random student be taking German in 1904 is 0.654. Computations like this carried out for the studies in Dexter's tables result in the following table.

With regard to some of the other subjects tabulated by the Bureau of Education, I am not able to draw any conclusions from Dexter's tables and other data. Some of his facts may be quoted as supplementing the table above.

This goes far to explain the increase in the percentage of students studying foreign history, as tabulated in the commissioned report and shown on the curve-sheet.

Table III., in spite of the very inadequate data on which it is in part based, is capable of giving us a certain amount of information about the relations between election and schedule alteration and the data of the Bureau of Education. The columns headed "per cent.—if required" give in per cents. the probabilities for each study that a random student would be taking the subject if there were no elective system, as derived from Dexter's data, and hence also the percentages of students in the mass who would take the sub-

TABLE III⁴

Study	Per Cent.—if Required			Per Cent.—Actual			Actual	
	1894	1904	Ratio	1894	1904	Ratio	Required	
Latin.....	69.2	91.4	1.32	43.59	49.96	1.23	0.63	0.55
French.....	64.8	66.0	1.02	10.31	11.15	1.08	0.16	0.17
German.....	72.0	65.4	0.91	12.78	18.98	1.49	0.18	0.29
Algebra.....	47.7	53.1	1.11	52.71	56.23	1.07	1.10	1.06
Geometry, plane.....	24.2	30.4	1.26					
" solid.....	8.0	10.5	1.31					
" both.....	32.2	40.9	1.27	25.25	27.30	1.08	0.78	0.67
Physics.....	21.3	22.0	1.03	24.02	15.90	0.66	1.13	0.72
Chemistry.....	11.5	10.2	0.89	10.31	7.08	0.69	0.90	0.69
Geology.....	11.0	5.6	0.51	5.52 ⁵	2.79	0.51	0.50	0.50
Physical geography and physiography.....	29.8	27.0	0.91	22.44 ⁵	21.26	0.95	0.75	0.79

³ In this it is assumed that all schools dealt with are of the same size, which is inaccurate, but unavoidable.

⁴ Results computed from the articles of Hunter, Weckel, Ramsay and Whitney, published in *School Science and Mathematics* during the last two years, supplement the above table in part. But they depend on limited or fragmentary data. A complete census by the Bureau of Education would be of great value.

⁵ 1894-5 data.

ject under these conditions. In a way they measure the average opportunity for a student to take the subject. The column "ratio" gives the quotient of the per cent. for 1904 by that for 1894. It measures the extent of schedule change. The columns headed "per cent.—actual" are quoted from the commissioner's table. The "ratio" column is found in the same way. The columns headed "actual/required" check the accuracy

of the methods used, and show that in three places there are errors; for it is manifestly impossible that in 1894 or 1904 there could be more students taking algebra or physics than would take it were the subjects required. Besides, these columns tend in the clearest way to show the effect of the elective system; the ratios measure in a rough way the popularity of a study, when it is elective.

TABLE IV

Study	Per Cent. Schools Offering	
	1904	1904
Latin, four years	46	80
Physics	97	100
Chemistry, mostly in year III.	74	66
Astronomy	63	31
Physiology, mostly in years I. or II.	81	57
Trigonometry	23	44
English,* four years	52	68
English, less than four years, more than three years	12	32

For example: in spite of the great increase in the percentage of students taking Latin, the subject had in fact declined in popularity, as shown by the ratios, 1894, 0.63, 1904, 0.55; further, these ratios show that, after all, relatively few students took the subject in comparison with the opportunities.

TABLE V
The History Branches

	1894		1904	
	Per Cent. Offering	Length of Year	Per Cent. Offering	Length of Year
American	57	0.7	86	0.64
French	0	0.0	7	0.50
English	39	0.5	51	0.66
"Intensive"	0	0.0	5	1.00
Greek	47	0.5	57	0.50
Roman	50	0.5	57	0.50
General	46	1.0	61	1.00

Examining the table with this in view, we see that French has hardly changed, while German draws increasingly on the affections

*The separation into English literature and rhetoric or composition is not sharp, and is hard to tabulate.

of secondary students—may this be a reflex of the great influence of German thought in the universities, brought into the secondary schools by college-bred teachers? But both French and German have a low popularity, lower than any science. Algebra is the universal study, not generally elective, and so it is not surprising that its "popularity" should be represented by a number in the neighborhood of 1. The excess gives a rough idea of the errors inherent in my data, and the amount of guessing which has crept in. Geometry was in 1904 not so generally required as in 1894, and so shows a fall of popularity. Physics was in 1894 more generally required than in 1904, which accounts in part for the drop from about 1.00 to 0.72. The balance means real dislike for the subject. Geology and physical geography and physiography stay about where they were in popularity.

I am inclined to conclude from this table that, in spite of a general impression to the contrary, American boys and girls like the sciences, both exact and natural, better than they like the languages, *provided they only have as good a chance to get at them*; and the way to save the situation for science is to give them the chance early in the course. I assert with confidence that, had 80 per cent. of Dexter's schools in 1904 offered four years of chemistry and physics, instead of four years of Latin, as they did, we should have found the figures of percentages just about reversed, or even worse for Latin.

WILLARD J. FISHER

ITHACA, N. Y.,
December, 1911

THE SMITHSONIAN BIOLOGICAL SURVEY OF THE PANAMA CANAL ZONE

THE Biological Survey of the Panama Canal Zone, begun in December, 1910, and continued through the major part of 1911, is being pushed to completion before the opening of the canal in 1913. The second expedition sailed on January 9, to take up the work for another season, the botanist, Professor

Pittier, being the only naturalist who has remained in the field since the beginning of the survey. Although much interesting information has been collected, and a great many specimens secured, nothing like a complete report is ready.

The party will include Dr. Seth E. Meek, formerly of the Bureau of Fisheries, but now representing the Field Museum of Natural History; Mr. S. F. Hildebrand, of the Bureau of Fisheries, who will collect fishes, reptiles and amphibians; E. A. Goldman, of the Biological Survey, Department of Agriculture, who will collect birds and mammals, and Professor Charles D. Marsh, of the Bureau of Plant Industry, Department of Agriculture, who will collect and study the microscopic plant and animal life of the fresh waters of the zone.

Leaving New York on the steamship *Panama*, they will proceed to Cristobal, Canal Zone, their headquarters on the Atlantic coast, and there make preparations for a sojourn of four or five months in the field.

The life-areas on the zone will become confused as soon as the canal is opened and the waters of the Pacific and Atlantic watersheds are intermingled. It is particularly important on that account, that the present geographical distribution of animals and plants be recorded prior to that time, and this is especially true as regards the life of the fresh waters and the sea-coasts.

The work of the survey is carried on through the united efforts of the Smithsonian Institution, several of the government departments and the Field Museum of Natural History of Chicago, and the hearty cooperation of the Panama Canal Commission has been an important factor in the success of the undertaking.

As a preliminary of the work already accomplished, the Smithsonian has published four pamphlets. The first two (Nos. 2015 and 2053 of the Smithsonian Misc. Colls.) are by E. W. Nelson, of the Biological Survey, and describe a new humming-bird, a motmot and a bird of the genus *Pachysylvia*. The third, by E. A. Goldman, one of the naturalists of

the survey, contains a description of a new kingfisher.

Mr. Maxon, of the Division of Plants, National Museum, who accompanied Professor Henry Pittier to the Canal Zone last year, has published a description of a remarkable new fern (Smiths. Misc. Coll. No. 2055).

After all the new forms of animals and plants have been described it is proposed to publish general accounts of all the various collections and also one or more volumes containing a summary of the whole fauna and flora of the Canal Zone.

SCIENTIFIC NOTES AND NEWS

DR. J. A. ALLEN, curator of mammalogy and ornithology in the American Museum of Natural History, has resigned the editorship of *The Auk*, and the council of the American Ornithologists' Union, at the recent meeting in Philadelphia, chose Mr. Witmer Stone as his successor. Simultaneous with Dr. Allen's retirement Mr. Frank M. Chapman resigned as associate editor. Beginning in 1876 with the initial volume of the *Bulletin* of the Nuttall Ornithological Club, Dr. Allen guided the course of this journal and its successor *The Auk* since its establishment in 1884.

DR. J. WALTER FEWKES, of the Bureau of American Ethnology, has been reelected president of the American Anthropological Association. The next annual meeting of the association will be in Cleveland, Ohio, beginning on December 30, 1912, in affiliation with Section H of the American Association for the Advancement of Science.

DR. THEOBALD SMITH, professor of comparative pathology at Harvard and exchange professor at the University of Berlin during the present academic year, delivered his first lecture on January 8. His subject was "The Relation between Parasitism and Disease."

PROFESSOR GEORGE GRANT MACCURDY will be the delegate from Yale University to the eighteenth International Congress of Americanists to be held in London from May 27 to June 1, 1912.

MR. ALEX. WETMORE, of the Biological Survey, U. S. Department of Agriculture, is in Porto Rico this winter, cooperating with the Insular Board of Agriculture in studying the economic relations of the birds and mammals of the island.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist, U. S. Department of Agriculture, has returned from Panama. About two months were spent in the Canal Zone and other parts of Panama, where he was a member of the Smithsonian Biological Survey, and about two months in the five Central American Republics. Nearly 200 species of grasses, represented by 565 numbers, were obtained in Panama and 760 numbers of grasses in Central America. While in Panama a trip was made to the extinct volcano Chiriqui, which has an altitude of a little over 11,000 feet. Besides several novelties there were collected many species heretofore known only from South America. Mr. Hitchcock was accompanied by his son, Frank H. Hitchcock, with whose aid he was able to obtain many duplicates.

WE learn from *The Auk* that Mr. Samuel N. Rhoads has returned from Ecuador after collecting at various points along the railroad which runs from Guayaquil to Quito, especially at Bucay (975 feet), on the Chanchan River (2,000 feet), Huigra (4,000 feet), Mt. Pichincha (8,000 feet), Riobamba (10,000 feet) and in the vicinity of Quito. He brought back about 1,600 birds, some mammals and reptiles and a number of invertebrates. His collection is now at the Academy of Natural Sciences, Philadelphia.

PROFESSOR L. HEKTOEN, of the University of Chicago, gave six lectures on the Herter foundation of the University and Bellevue Hospital Medical College, beginning on January 8. The subject of the lectures was "Immunity."

DR. WILLIAM H. WELCH, professor of pathology at the Johns Hopkins University, will give the lectures on the Barbour-Page foundation at the University of Virginia.

MR. GANO DUNN, president of the American Institute of Electrical Engineers, was the guest of honor at the annual dinner of the Ithaca Section of the institute, held on January 10. His subject was "The Kind of a Man that makes a Good Engineer."

MR. C. A. SELEY, mechanical engineer of the Rock Island Lines, delivered an address before the students and faculty of the College of Engineering of the University of Illinois, on January 4, 1912, on "Conference Committee Methods in handling Railway Legislation on Mechanical Matters."

BEFORE the Geographic Society of Chicago on January 12 a lecture was given by Professor R. H. Whitbeck, of the University of Wisconsin, the title of the lecture being "Geographical Names and the Stories they Tell."

AT the dedication of the Gauss monument on the Hohenhagen, near Dransfeld, the memorial address was delivered by Professor W. Voigt, of the University of Göttingen.

THE daily papers announce that Dr. Simon, the bacteriologist of Zurich, has died as the result of a bite from an inoculated mouse.

THE death is also announced of Dr. Stephan Lindeck, member of the Charlottenburg Reichsanstalt.

THE Society of American Bacteriologists, at its recent meeting in Washington, elected the following officers:

President—Dr. William H. Park, director of the Research Laboratories, City of New York.

Vice-president—Professor C. E. A. Winslow, College of the City of New York.

Secretary-treasurer—Dr. Charles E. Marshall, Michigan Agricultural College, East Lansing.

Council—Dr. W. J. MacNeal, New York Post-Graduate Schools, New York City; Dr. Otto Rahn, Michigan Agricultural College, East Lansing; Dr. H. D. Pease, 39 West 38th Street, New York City; Dr. John F. Anderson, director of Hygienic Laboratory, Washington.

Delegate to the A. A. A. S.—Professor D. H. Bergey, University of Pennsylvania.

DR. G. STANLEY HALL, president of Clark University, is giving a course of six lectures on "The Founders of Modern Psychology"

before the department of psychology of Columbia University. The lectures are on January 16, 17, 23, 24, 30 and 31, at 4.10 p.m. The subjects are as follows:

Edward D. Zeller, *the scholar in his field*. The historian of ancient philosophy, his personality, his learning, his career, characteristics as a teacher, his essays, historical method and position, and an estimate of his achievements.

Edward von Hartmann, *the philosopher of temperament*. Personal reminiscences of his traits, his early writings, outline of his chief positions in his major and his minor contributions, critique of his type of pessimism.

Hermann Lotze, *the harmoniser*. The man and professor, his early work as physiologist and physician, the chief position taken in his Microcosm and his Ethics, his system as an expression of his character and its historical significance. Why he never left a school.

Theodor Fechner, *the animist*. His life, works, personal reminiscences, his mystic papers, his unique type of idealism, his lapse to spiritualism, the psychophysics law and what it meant to him.

Hermann von Helmholtz, *the ideal man of science*. His boyhood, growth and early manhood, his methods of life and work, his essays and addresses, the fourth dimension of space, characterization of the chief discoveries in his optics and acoustics and their results.

Wilhelm Wundt, *a scientific philosopher*. His early career, his methods of work, his early, and a glimpse at his later, writings, some criticisms and appreciations.

Nature states that the jubilee annual meeting of the Yorkshire Naturalists' Union was held at Heckmondwike, on December 16, at the place where fifty years ago the union had its birth. There were more than three hundred members present, including delegates from thirty-eight affiliated societies of the Yorkshire Naturalists' Union. The presidential address of Mr. Alfred Harker, F.R.S., on "Petrology in Yorkshire," was delivered. Mr. T. Sheppard resigned his position as honorary secretary, and in view of his nine years' work in that position was elected an honorary life member of the union. Mr. W. Cash was similarly honored. Mr. J. W. Taylor, of Leeds, was elected president for 1912. The new sec-

retaries are Dr. T. W. Woodhead and Mr. W. E. L. Wattam, Technical College, Huddersfield. The annual meeting for 1912 will be held at Hull on December 14.

As we learn from the New York *Evening Post* an old landmark which has figured extensively in the medical and surgical progress of the city for nearly a half century is to be sold by auction on February 1. The property is the old Mott Memorial at No. 64 Madison Avenue, opposite Madison Square Garden. The memorial was founded in 1866 by the widow of Dr. Alexander Mott, who in his day was one of the foremost surgeons of this country. Many surgical and obstetrical instruments, invented by Dr. Mott, as well as numerous morbid specimens he collected during his travels, were partly destroyed with the burning of the Medical College on Fourteenth Street. His widow succeeded in gathering mementos of his life and placed them in the Madison Avenue house, which was incorporated as the Mott Memorial in 1866, and conducted for many years by Professor Alexander B. Mott. It contained a library of more than 4,000 volumes, exclusively on medical and surgical topics, which were consulted freely by students and physicians. In the will of Mrs. Mott there was a proviso that in the event that the property should become burdensome the trustees were directed to sell it. The Memorial, after several years of uncertainty, during which the trustees hoped a way could be devised to perpetuate it, was closed in 1909, and the books, instruments and plates were transferred to the New York Academy of Medicine, of which Dr. Mott was president for a long period.

THE fourteenth International Congress of Anthropology and Prehistoric Archeology, will be held at Geneva, Switzerland, during the first week of September, 1912. The last session of this congress was held at Monaco in the spring of 1906.

THE *American Museum Journal* reports that Mr. Stefánsson, of the Museum's Arctic expedition, has made a discovery of an archeological nature at his last winter camp near

Pt. Stevens, Parry Peninsula. According to his report a great deal of pottery is found upon old village sites, some at a depth of several feet. This pottery is of similar type to that found among and lately manufactured by some of the Alaskan Eskimos. Pottery has so far not been reported from any of the central and eastern Eskimos. It was formerly assumed that the presence of pottery among the Alaskan Eskimos was to be explained as indicating forms copied from Siberian or neighboring American tribes. The recent discoveries of Mr. Stefánsson indicate that the art of pottery among the Eskimos must have been of ancient origin and at one time very widely distributed. Furthermore Mr. Stefánsson reports that other objects he finds are similar in type to those described by Professor Boas, discovered by Captain George Comer in ancient village sites in Southampton Island, Hudson Bay. These were also similar to objects recently discovered in Greenland, leading to the conclusion that older types of Eskimo culture must have been much more uniform throughout the entire stretch of Arctic America than at present. Mr. Stefánsson's find of similar objects on the west side of Hudson Bay makes it more probable that there was formerly but a single type of Eskimo culture from Alaska to Greenland.

To demonstrate the process involved in changing raw materials into finished products, the course in commerce at the University of Wisconsin maintains a commercial museum for the use of the students in the course. Detailed exhibits of almost every product that has any commercial value are included. Among the most instructive are those of cotton, wool, silk, the grains and their products, rubber, steel and aluminum products and structural fibers. Different forms of money used in all parts of the world, and a collection of coins representing the circulating media of some of the less civilized peoples, are interesting features of this museum.

SUBJOINED are the names of the members of the commission on resuscitation from shock, selected by the American Medical Association at the request of the National Electric Light

Association. This is the result of a series of conferences on the subject held during the past year by representatives of the leading engineering societies, officials of the government, etc. *Resuscitation Commission*: Dr. W. B. Cannon (*chairman*), department of physiology, Harvard Medical School. *Nominated by the American Medical Association*: Dr. Yandell Henderson, department of physiology, Yale University; Dr. Geo. W. Crile, 214 Osborn Building, Cleveland, Ohio; Dr. S. J. Meltzer, Rockefeller Institute. *Nominated by the National Electric Light Association*: Dr. Edward A. Spitzka, professor of anatomy, Jefferson Medical College; Mr. W. C. L. Eglin, Philadelphia Electric Company. *Nominated by the American Institute of Electrical Engineers*: Professor Elihu Thomson, ex-president of the American Institute of Electrical Engineers, Lynn, Mass.; Dr. Arthur E. Kennelly, Harvard University; Mr. W. D. Weaver (*secretary*), editor *Electrical World*, New York City. A conference was held on December 16 by the president and secretary of the commission and some preliminary work was mapped out. These steps will be followed up by an early meeting of the full commission, probably in New York in January, after which the plans adopted for the investigation will be vigorously pushed. It is felt that the much-needed revision of rules and practise in regard to this highly important subject will now be taken up under the best auspices and that authoritative conclusions will be reached. The officers of the association are highly encouraged in knowing that the question will receive the serious attention of these eminent medical men and that they regard it as worthy of their special study.

UNIVERSITY AND EDUCATIONAL NEWS

DR. JOHN GRIER HIBBEN, Stuart professor of logic, has been elected president of Princeton University.

DR. and MRS. CHARLES WALDSTEIN, of Cambridge, England, have given \$5,000 to Columbia University to establish lectures on the foreign policy of the United States.

THE trustees of Northwestern University have announced a gift of \$8,000 from the estate of Mrs. Ellen Sage which is administered by Mr. N. M. Jones, for the establishment of three scholarships: one in the College of Liberal Arts, one in the Medical School and one in the Law School, to be known as the Rufus H. Sage scholarships.

THE degree of bachelor of business administration will hereafter be conferred on graduates of Northwestern University School of Commerce who have had two years' regular college work and have spent two years in the School of Commerce.

BEGINNING with September, 1914, the Schools of Mines, Engineering and Chemistry of Columbia University, which comprise the faculty of applied science, will be substantially graduate schools, a baccalaureate degree being required for admission. But students will have the privilege of following a combined collegiate and professional course in engineering as they now have in law, medicine and teaching. The strictly technical or professional course of study will be three years in length instead of four as at present.

THE trustees of Teachers College, Columbia University, have created a School of Practical Arts, to comprise the present Schools of Household and Industrial Arts and the departments of fine arts, music and physical education. To this end there has been constituted a faculty of education, comprising the dean and the professors whose work is largely in education, who are to direct the School of Education, and the faculty of practical arts, including the professors of fine arts, music, household arts, industrial arts and hygiene and physical training. To this latter faculty is entrusted the development of the new School of Practical Arts, which is to offer a new type of university education—a four-year course, comprising both academic and vocational courses.

THE technique of printing and publishing is the subject of a new course to be given in connection with the work in journalism at the University of Wisconsin, beginning in Feb-

ruary. The course will consist of practical talks and laboratory work on typographical composition, engraving processes, printing and similar topics. The study is intended primarily for students of engineering, agriculture, commerce, pharmacy, chemistry and other technical subjects, who desire to familiarize themselves with methods of printing and publishing in order to contribute to or do editorial work on scientific, technical and trade publications. A course in technical and trade journalism, to include lectures and practise in all the details of the work of the editor and the contributor on scientific, technical and trade publications, has also been arranged to be given next year.

HERBERT SHAW PHILBRICK, assistant professor of mechanical engineering at the University of Missouri, has been appointed professor of that subject in the College of Engineering of Northwestern University.

DR. H. E. BUCHANAN has been appointed professor of mathematics at the University of Tennessee.

PROFESSOR GEORG FABER, of the Technical School at Stuttgart, has been called to a chair of mathematics at Königsberg.

DISCUSSION AND CORRESPONDENCE

THE ADMINISTRATION OF THE WEEKS ACT

TO THE EDITOR OF SCIENCE: In consideration of Professor Very's letter in SCIENCE of January 5, I wish only to bring to the attention of the readers of SCIENCE section 6 of the Weeks Act, which has been interpreted to require an actual examination by the Geological Survey and a report based thereon which shall consist of a showing of facts rather than an expression of opinion.

Section 6. That the Secretary of Agriculture is hereby authorized and directed to examine, locate and recommend for purchase such lands as in his judgment may be necessary to the regulation of the flow of navigable streams, and to report to the National Forest Reservation Commission the results of such examinations: *Provided*, That before any lands are purchased by the National Forest Reservation Commission said lands

shall be examined by the Geological Survey and a report made to the Secretary of Agriculture, showing that the control of such lands will promote or protect the navigation of streams on whose watersheds they lie.

Those who are familiar with the eventful history leading up to the passage of the Weeks Act know that the principle invoked in section 6 was absolutely essential both to insure the constitutionality of the measure and to secure its passage. The administrative officer, however keenly he may appreciate the spirit which encouraged the movement for the preservation of the Appalachian forests, can not disregard the plain letter of the law on the statute book.

GEO. OTIS SMITH

U. S. GEOLOGICAL SURVEY

SUGGESTIONS FOR THE CLEVELAND MEETING

TO THE EDITOR OF SCIENCE: Regarding the preparations for the meeting of the American Association for the Advancement of Science at Cleveland next year, I desire to suggest the advisability of concentrating the places of meeting so far as practicable, in order that the meeting rooms may be more conveniently found, and persons who wish to pass from one meeting place to another in order to hear a large number of papers read, may be able to do so.

Much of the benefit of these meetings depends on easy access afforded them. For this reason, the best arrangements in many years was that provided in the Central High School at St. Louis. There the basement, and the first- and second-floor classrooms were used for the different sections. Geographers could in a minute's time pass out of their meeting place to hear a paper in the session of the economist and statistician, or *vice versa*. Strangers coming in the building found the directory at the entrance, which told where each section was meeting and the room. There was no wandering about the campus, as at Chicago where some of the sections were located on the third floor of buildings; nor was there any fear of intrusion or collision with professors who had classes to hear, as at the Institute of Technology, Boston; nor was

there any wandering about the streets to find where particular sections met, as in Baltimore.

A central building with wide hallways, the posting of a large directory at some outside point on a thoroughfare and the placarding of rooms, with the placard standing at right angles to the door when closed, with somebody at hand to make additional placards as needed—these suggestions seem to me worth while considering to help make our Cleveland meeting one of the best, if not the best on record.

JOHN FRANKLIN CROWELL

CHROMOSOMES IN WHEAT AND RYE

In my paper entitled "A Theory of Mendelian Phenomena"¹ I referred to rye as having a small number of chromosomes—"six, I believe," while wheat has "40 or more," and called attention to a possible relation of these supposed facts to the great difference in variability of these two species. This reference to chromosome numbers was made on the basis of a statement made to me some years ago by a student who had made some studies of the subject. Mr. Orland E. White, of the Bussey Institution, calls my attention to the studies of Overton and of Koernicke, which indicate that wheat has sixteen chromosomes (2*X* number).

W. J. SPILLMAN

WASHINGTON, D. C.

HOW A FALLING CAT TURNS OVER

TO THE EDITOR OF SCIENCE: In your last issue Professor W. S. Franklin mentions having given a valid explanation of how a cat is able to light on his feet when he is dropped back downwards. He does not state what this explanation was; but gives in full a different valid explanation offered by Professor J. F. Hayford. No statement is made as to which explanation agrees with the actual performance of the cat, so it may be of interest to call attention to a set of kinematograph pictures of a falling cat, published as Plate II. of H. Crabtree's "Spinning Tops and Gyroscopic Motion." These pictures corroborate

¹ American Breeders' Association, Report VI.

fully the following explanation given in the accompanying text:

"Let us regard the cat as made up of a fore part and a hind part, whose moments of inertia I_1 , I_2 are equal when the legs are fully extended at right angles to the body. The photographs given in Plate II. show that it first contracts its fore legs (thereby making I_1 less than I_2) and then turns its fore part round. This latter action necessitates the hind part being turned in the opposite direction (since the total angular momentum about the axis is zero) but to a less extent, since I_2 is greater than I_1 . The animal then contracts its hind legs, extends its forelegs, and gives its hind part a turn. This necessitates the fore part being turned in the reverse direction but, again, to a less extent, since I_1 is now greater than I_2 . It will thus be seen that by continued action of this kind the cat can turn itself through any required angle, though at no time has it any angular momentum about its 'axis.'"

The explanation offered by Professor Hayford, although a possible one, accordingly does not agree with the actual performance of a cat, as observed by photography.

J. R. BENTON

UNIVERSITY OF FLORIDA,
December 18, 1911

SCIENTIFIC BOOKS

The Wilderness of the Upper Yukon: A Hunter's Explorations for Wild Sheep in Sub-Arctic Mountains. By CHARLES SHELDON. New York, Charles Scribner's Sons. 1911. 8vo. Pp. xxi + 354; 4 colored and 46 half-tone plates; 4 maps, one in colors.

The distribution and relationships of the mountain sheep of Canada and Alaska present one of the most interesting and puzzling problems in North American mammalogy. For the purpose of obtaining more definite information on this subject Mr. Sheldon, a hunter-naturalist of well-known qualifications for such a task, spent the seasons of 1904 and 1905 in the Northern Rockies, exploring the Ogilvie, the Selwyn and Plateau mountains and the Watson River country in 1904, and

the Pelly, Rose and Glenlyon mountains in 1905. As a narrative of exploration in practically new fields, the book is an important contribution to our knowledge of the physical conditions and natural history of the region traversed, aside from its bearing upon the special quest for which these journeys were undertaken. Its excellent literary form, its abundant and admirable illustrations and the author's enthusiasm and sympathy with his surroundings, add a value and a charm to his pages unusual in books of hunting adventure. Maps are given of the districts traversed, excellent half-tones illustrate scenic features and there are four colored plates from drawings by Carl Rungius of sheep and other big game.

The sheep of northern Canada and Alaska are quite different from the well-known bighorn of the Rocky Mountains of southern Canada, the United States and northern Mexico. The first northern form to become scientifically known was the *Ovis dalli* described by E. W. Nelson in 1884 from specimens collected in the upper Yukon region of Alaska. This sheep is pure white at all seasons except for adventitious staining from soil or vegetation; it is smaller and has less massive horns than the various forms of the Rocky Mountain bighorn.

In 1897 a black form was described as *Ovis stonoi* from specimens obtained in the Cheonoe Mountains south of the Stikine River in northern British Columbia. Although the Alaska form is pure white, and the other so dark colored as to be known as the black sheep, the structural differences that characterize them are slight and inconstant.

A few years later (in 1901) a sheep intermediate in coloration between the white and black sheep was described as *Ovis fannini*, based on specimens collected near Dawson City. As the sheep of this general region became better known it was found that the sheep of the *fannini* type were very unstable in respect to coloration and were apparently intergrades between the white form of Alaska, the Yukon and Northwest territories and the black form of northern British Columbia.

This was about the sum of our knowledge of these sheep when Mr. Sheldon set out in 1904 and 1905 to make a special study of the sheep question of the northern Rockies, and to trace out their geographical and physical relationships. Chapter XX. of this book gives a summary of the results of his two seasons' work, and is illustrated by a map in colors showing the known distribution of the white and black sheep of Canada and Alaska, their areas of intergradation and the phases characteristic of special districts. Facing the map are half-tone figures of nine stages of color variation, with explanatory text. The subject is thus graphically and clearly illustrated by the distribution map, the facing explanatory text and shaded figures. The area embraced extends from about latitude 55° to latitude 70° . In Alaska, from the Arctic coast south to latitude 60° , and in Yukon Territory and northeastward in the Mackenzie Mountains to about latitude 62° (generally speaking), the sheep are pure white, except in the Tanana Hills south of the Yukon River, where the white coat is varied with a few black hairs and slight indications of the color pattern of the *fannini* type; in British Columbia south of the Stikine River the sheep are uniformly black; but over an intervening region of from approximately six hundred and fifty miles north and south and about one hundred and fifty to two hundred miles east and west, "there is no area in which the color of the sheep is uniform."

Mr. Sheldon indicates on his map five areas (*a*, *b*, *c*, *d*, *e*) where the sheep are either pure white (*a*), or black (*e*), or are of intermediate or mixed shades (*b*, *c*, *d*); the *b* grade is nearly white, the *d* grade nearly black, *c* being the middle phase or the *fannini* type, which is intermediate geographically as well as in color.

The facts of intergradation are thus forcibly and clearly presented—an intergradation continuous and gradual from one extreme phase to the other through a vast expanse of country. The cause of this extensive and gradual merging of these two widely diverse color types of sheep is not so easily demonstrable. Has it

resulted from interbreeding or is it due to environment? Mr. Sheldon favors the former hypothesis, but admits the possibility of its having been "produced by subtle and indeterminate changes of environment to a much greater extent than the facts seem to me [him] to warrant."

The large size of these animals and the striking color differences between the extreme phases that are thus shown to intergrade render this an impressive instance of intergradation, but parallel cases, though less striking, in other animals usually seem explainable satisfactorily, and in many instances beyond question, on the hypothesis of the action of diverse conditions of environment. But whatever conclusion may finally be reached as to the cause, great credit is due Mr. Sheldon for his contribution of facts through a successful reconnaissance of the almost inaccessible haunts of the sheep in the Northern Rockies where lay the key to the problem—an undertaking few would have the hardihood to project or the endurance and persistence to accomplish. Besides the facts of variation and range already outlined, his contribution to the life-history of these animals is of noteworthy importance, while the wide range of individual variation among members of the same herd, not only as regards coloration, but in respect to size, shape and curvature of the horns is noted in detail. He has also presented to the National Museum the large series of specimens of sheep obtained by him on his expeditions which go far to substantiate the facts of intergradation recorded and illustrated in his book, which may be read with equal interest by the naturalist, the big game hunter and the general reader.

J. A. ALLEN

Principia Mathematica. By ALFRED NORTH WHITEHEAD, Sc.D., F.R.S., Fellow and Lecturer of Trinity College, Cambridge, and BERTRAND RUSSELL, M.A., F.R.S., Lecturer and late Fellow of Trinity College, Cambridge. Cambridge University Press. 1910. Vol. I., pp. xiii + 666.

Mathematicians, many philosophers, logicians and physicists, and a large number of other people are aware of the fact that mathematical activity, like the activity in numerous other fields of study and research, has been in large part for a century distinctively and increasingly critical. Every one has heard of a critical movement in mathematics and of certain mathematicians distinguished for their insistence upon precision and logical cogency. Under the influence of the critical spirit of the time mathematicians, having inherited the traditional belief that the human mind can know some propositions to be true, convinced that mathematics may not contain any false propositions, and nevertheless finding that numerous so-called mathematical propositions were certainly not true, began to reexamine the existing body of what was called mathematics with a view to purging it of the false and of thus putting an end to what, rightly viewed, was a kind of scientific scandal. Their aim was truth, not the whole truth, but nothing but truth. And the aim was consistent with the traditional faith which they inherited. They believed that there were such things as self-evident propositions, known as axioms. They believed that the traditional logic, come down from Aristotle, was an absolutely perfect machinery for ascertaining what was involved in the axioms. At this stage, therefore, they believed that, in order that a given branch of mathematics should contain truth and nothing but truth, it was sufficient to find the appropriate axioms and then, by the engine of deductive logic, to explicate their meaning or content. To be sure, one might have trouble to "find" the axioms and in the matter of explication one might be an imperfect engineer; but by trying hard enough all difficulties could be surmounted for the axioms existed and the engine was perfect. But mathematicians were destined not to remain long in this comfortable position. The critical demon is a restless and relentless demon; and, having brought them thus far, it soon drove them far beyond. It was discovered that an axiom of a given set could be replaced by its contradictory and

that the consequences of the new set stood all the experiential tests of truth just as well as did the consequences of the old set, that is, perfectly. Thus belief in the self-evidence of axioms received a fatal blow. For why regard a proposition self-evident when its contradictory would work just as well? But if we do not know that our axioms are true, what about their consequences? Logic gives us these, but as to their being true or false, it is indifferent and silent.

Thus mathematics has acquired a certain modesty. The critical mathematician has abandoned the search for truth. He no longer flatters himself that his propositions are or can be known to him or to any other human being to be true; and he contents himself with aiming at the correct, or the consistent. The distinction is not annulled nor even blurred by the reflection that consistency contains immanently a kind of truth. He is not absolutely certain, but he believes profoundly that it is possible to find various sets of a few propositions each such that the propositions of each set are compatible, that the propositions of such a set imply other propositions, and that the latter can be deduced from the former with certainty. That is to say, he believes that there are systems of coherent or consistent propositions, and he regards it his business to discover such systems. Any such system is a branch of mathematics. Any branch contains two sets of ideas (as subject matter, a third set of ideas are used but are not part of the subject matter) and two sets of propositions (as subject matter, a third set being used without being part of the subject): a set of ideas that are adopted without definition and a set that are defined in terms of the others; a set of propositions adopted without proof and called assumptions or principles or postulates or axioms (but not as true or as self-evident) and a set deduced from the former. A system of postulates for a given branch of mathematics—a variety of systems may be found for a same branch—is often called the foundation of that branch. And that is what the layman should think when, as occasionally happens,

he meets an allusion to the foundation of the theory of the real variable, or to the foundation of Euclidean geometry or of projective geometry or of *Mengenlehre* or of some other branch of mathematics. The founding, in the sense indicated, of various distinct branches of mathematics is one of the great outcomes of a century of critical activity in the science. It has engaged and still engages the best efforts of men of genius and men of talent. Such activity is commonly described as fundamental. It is very important, but fundamental in a strict sense it is not. For one no sooner examines the foundations that have been found for various mathematical branches and thereby as well as otherwise gains a deep conviction that these branches are constituents of something different from any one of them and different from the mere sum or collection of all of them than the question supervenes whether it may not be possible to discover a foundation for mathematics itself such that the above-indicated branch foundations would be seen to be, not fundamental to the science itself, but a genuine part of the superstructure. That question and the attempt to answer it are fundamental strictly. The question was forced upon mathematicians not only by developments within the traditional field of mathematics, but also independently from developments in a field long regarded as alien to mathematics, namely, the field of symbolic logic. The emancipation of logic from the yoke of Aristotle very much resembles the emancipation of geometry from the bondage of Euclid; and, by its subsequent growth and diversification, logic, less abundantly perhaps but not less certainly than geometry, has illustrated the blessings of freedom. When modern logic began to learn from such a man as Leibniz (who with the most magnificent expectations devoted much of his life to researches in the subject) the immense advantage of the systematic use of symbols, it soon appeared that logic could state many of its propositions in symbolic form, that it could prove some of these, and that the demonstration could be conducted and expressed in the language of symbols. Evidently such a

logic looked like mathematics and acted like it. Why not call it mathematics? Evidently it differed from mathematics in neither spirit nor form. If it differed at all, it was in respect of content. But where was the decree that the content of mathematics should be restricted to this or that, as number or space? No one could find it. If traditional mathematics could state and prove propositions about number and space, about relations of numbers and of space configurations, about classes of numbers and of geometric entities, modern logic began to prove propositions about propositions, relations and classes, regardless of whether such propositions, relations and classes have to do with number and space or any other specific kind of subject. At the same time what was admittedly mathematics was by virtue of its own inner developments transcending its traditional limitations to number and space. The situation was unmistakable: traditional mathematics began to look like a genuine part of logic and no longer like a separate something to which another thing called logic applied. And so modern logicians by their own researches were forced to ask a question, which under a thin disguise is essentially the same as that propounded by the bolder ones among the critical mathematicians, namely, is it not possible to discover for logic a foundation that will at the same time serve as a foundation for mathematics as a whole and thus render unnecessary (and strictly impossible) separate foundations for separate mathematical branches?

It is to answer that great question that Messrs. Whitehead and Russell have written "*Principia Mathematica*"—a work consisting of three large volumes, the first being in hand, the second and third soon to appear—and the answer is affirmative. The thesis is: it is possible to discover a small number of ideas (to be called primitive ideas) such that all the other ideas in logic (including mathematics) shall be definable in terms of them, and a small number of propositions (to be called primitive propositions) such that all other propositions in logic (including mathematics) can be demonstrated by means of

them. Of course, not all ideas can be defined—some must be assumed as a working stock—and those called primitive are so called merely because they are taken without definition; similarly for propositions, not all can be proved, and those called primitive are so called because they are assumed. It is not contended by the authors (as it was by Leibniz) that there exist ideas and propositions that are absolutely primitive in a metaphysical sense or in the nature of things; nor do they contend that but one sufficient set of primitives (in their sense of the term) can be discovered. In view of the immeasurable wealth of ideas and propositions that enter logic and mathematics, the authors' thesis is very imposing; and their work borrows some of its impressiveness from the magnificence of the undertaking. It is important to observe that the thesis is not a thesis of logic or of mathematics, but is a thesis about logic and mathematics. It can not be proved syllogistically; the only available method is that by which one proves that one can jump through a hoop, namely, by actually jumping through it. If the thesis be true, the only way to establish it as such is to produce the required primitives and then to show their adequacy by actually erecting upon them as a basis the superstructure of logic (and mathematics) to such a point of development that any competent judge of such architecture will say: "Enough! I am convinced. You have proved your thesis by actually performing the deed that the thesis asserts to be possible."

And such is the method the authors have employed. The labor involved—or shall we call it austere and exalted play?—was immense. They had predecessors, including themselves. Among their earlier works Russell's "Principles of Mathematics" and Whitehead's "Universal Algebra" are known to many. The related works of their predecessors and contemporaries, modern critical mathematicians and modern logicians, Weierstrass, Cantor, Boole, Peano, Schröder, Peirce and many others, including their own former selves, had to be digested, assimilated and transcended. All this was done, in the course

of more than a score of years; and the work before us is a noble monument to the authors' persistence, energy, acumen and idealism. A people capable of such a work is neither crawling on its belly nor completely saturated with commercialism nor wholly philistine. There are preliminary explanations in ordinary language and summaries and other explanations are given in ordinary language here and there throughout the book, but the work proper is all in symbolic form. Theoretically the use of symbols is not necessary. A sufficiently powerful god could have dispensed with them, and, unless he were a divine spendthrift, he would have done so, except perhaps for the reason that whatever is feasible should be done at least once in order to complete the possible history of the world. But whilst the employment of symbols is theoretically dispensable, it is, for man, practically indispensable. Many of the results in the work before us could not have been found without the help of symbols, and even if they could have been thus found, their expression in ordinary speech, besides being often unintelligible, owing to complexity and involution, would have required at least fifteen large volumes instead of three. Fortunately the symbology is both interesting and fairly easy to master. The difficulty inheres in the subject itself.

The initial chapter, devoted to preliminary explanations that any one capable of nice thinking may read with pleasure and profit, is followed by a chapter of 30 pages dealing with "the theory of logical types." Mr. Russell has dealt with the same matter in volume 30 of the *American Journal of Mathematics* (1908). One may or may not judge the theory to be sound or adequate or necessary and yet not fail to find in the chapter setting it forth both an excellent example of analytic and constructive thinking and a worthy model of exposition. The theory, which, however, is recommended by other considerations, originated in a desire to exclude from logic automatically by means of its principles what are called illegitimate totalities and therewith a subtle variety of contradiction and vicious circle fallacy that, owing their presence to the

non-exclusion of such totalities, have always infected logic and justified skepticism as to the ultimate soundness of all discourse, however seemingly rigorous. (Such theoretic skepticism may persist anyhow, on other grounds.) Perhaps the most obvious example of an illegitimate totality is the so-called class of all classes. Its illegitimacy may be shown as follows. If A is a class (say that of men) and E is a member of it, we say, E is an A . Now let W be the class of all classes such that no one of them is a member of itself. Then, whatever class x may be, to say that x is a W is equivalent to saying that x is not an x , and hence to say that W is a W is equivalent to saying that W is not a W ! Such illegitimate totalities (and the fallacies they breed) are in general exceedingly sly, insinuating themselves under an endless variety of most specious disguises, and that, not only in the theory of classes but also in connection with every species of logical subject-matter, as propositions, relations and propositional functions. As the propositional function—any expression containing a real (as distinguished from an apparent) variable and yielding either non-sense or else a proposition whenever the variable is replaced by a constant term—is the basis of our authors' work, their theory of logical types is fundamentally a theory of types of propositional functions. It can not be set forth here nor in fewer pages than the authors have devoted to it. Suffice it to say that the theory presents propositional functions as constituting a summitless hierarchy of types such that the functions of a given type make up a legitimate totality; and that, in the light of the theory, truth and falsehood present themselves each in the form of a systematic ambiguity, the quality of being true (or false) admitting of distinctions in respect of order, level above level, without a summit. When Epimenides, the Cretan, says that all statements of Cretans are false, and you reply that then his statement is false, the significance of "false" here presents two orders or levels; and logic must by its machinery automatically prevent the possibility of confusing them.

Next follows a chapter of 20 pages, which all philosophers, logicians and grammarians ought to study, a chapter treating of Incomplete Symbols wherein by ingenious analysis it is shown that the ubiquitous expressions of the form "the so and so" (the "the" being singular, as "the author of Waverley," "the sine of a ," "the Athenian who drank hemlock," etc.) do not of themselves denote anything, though they have contextual significance essential to discourse, essential in particular to the significance of identity, which, in the world of discourse, takes the form of " a is the so and so" and not the form of the triviality, a is a .

After the introduction of 88 pages, we reach the work proper (so far as it is contained in the present volume), namely, Part I.: Mathematical Logic. Here enunciation of primitives is followed by series after series of theorems and demonstrations, marching through 578 pages, all matter being clad in symbolic garb, except that the continuity is interrupted here and there by summaries and explanations in ordinary language. Logic it is called and logic it is, the logic of propositions and functions and classes and relations, by far the greatest (not merely the biggest) logic that our planet has produced, so much that is new in matter and in manner; but it is also mathematics, a prolegomena to the science, yet itself mathematics in the most genuine sense, differing from other parts of the science only in the respects that it surpasses these in fundamentality, generality and precision, and lacks traditionality. Few will read it, but all will feel its effect, for behind it is the urgency and push of a magnificent past: two thousand five hundred years of record and yet longer tradition of human endeavor to think aright.

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A LETTER OF LAMARCK

LETTERS of Lamarck are not often found. M. Landrieux, who has recently published a life of Lamarck, states that "one can count the number of his letters which have come

down to us,"¹ and that "even his autographs are exceedingly rare."

It is of interest, therefore, that another letter in the hand of Lamarck has been discovered in Paris (it is now in my possession), and as it contains several data regarding his life, it may be worthy of publication. It reads as follows:

PARIS ce 16 floréal au 5 de la Rep.

Lamarck professeur au Museum d'hist. naturelle
Au Citoyen Cyalis Lavaux Directeur de la
1^{ère} division des domaines

Citoyen

ayant reçu de Songeons, département de l'oise, l'avis que la vente des biens que j'ai Soumissionnés étoit Suspendue et qu'on avoit méconnue l'autorité du Ministre des finances, j'ai eu l'honneur de vous faire passer une lettre par laquelle je me Suis plaint de la Conduite du département à cet égard. j'apprends en ce moment que la personne qui m'a fait passer cet avis m'a trompé, et que le département de l'oise n'a encore pris aucun arrêté qui me fut préjudiciable. je me hâte de vous en instruire pour vous prier de ne donner aucune Suite à la lettre que j'ai eu l'honneur de vous faire passer.

quand le Ministre de l'interieur aura fait passer à Son Collegue le Ministre des finances les Conditions de la vente de ma Collection, je me recommande à votre bienveillance que vous avez déjà bien voulu me promettre, et pour laquelle je vous prie d'agréer ma vive reconnaissance et mes Salutations fraternelles.

LAMARCK

It will be seen from the above details that Lamarck, like many members of his class, was troubled in matters of property during the upheaval of the revolution. He had maintained his post, poor as it was, in the Jardin des Plantes in 1790, and had made a strong plea for a reorganization of this institution under the republican régime: he had even (1793) gained the day and during the most democratic epoch, he was distinguished as one of the first professors placed in charge of the collections of the Jardin des Plantes. The present letter shows, none the less, that in 1794 Lamarck was concerned about his property at Songeons.

¹ "Lamarck le Fondateur du Transformisme," 1909, p. 105.

The authorities had not, however, as he later ascertained, confiscated it, and ordered its sale. Still, times were bad and he was probably in financial straits, since he took the opportunity in the same letter to refer to the matter of the sale of his (private) collection, and to "pull a wire" more or less insistently.

BASHFORD DEAN

SPECIAL ARTICLES

THE APPARENT ANTAGONISM BETWEEN ELECTROLYTES AND NONCONDUCTORS

1. In a publication contained in SCIENCE, Vol. XXXIV., No. 887, pp. 928, Sumner makes the following statement: "Loeb's assertion that 'salts alone have such antagonistic effects' certainly does not apply to adult fishes. I need only call attention to the fact that cane-sugar solutions of certain strengths were found by me to very clearly defer the fatal action of the copper salts, both upon *Fundulus heteroclitus* and upon certain fresh-water species."

Thirteen years ago I pointed out the fundamental difference between the influence of electrolytes and nonelectrolytes upon life phenomena and in later publications called attention to the fact that this difference indicated an interaction between the electrolytes and colloids, especially the proteins, of the cells, which did not exist between nonelectrolytes and the same colloids of the cells. The further development of colloid chemistry and biology has shown that this conclusion was correct and fruitful. The fact that the toxic action of electrolytes upon the cells can be antagonized by electrolytes only is a special case of this more general rule. In 1902 Gies and I published an apparent exception to this rule, namely, that the toxic action of ZnSO_4 upon *Fundulus* eggs could be inhibited through the addition of cane-sugar; but we pointed out that in this case there is no antagonistic action between ZnSO_4 and cane-sugar in regard to the colloids of the egg (or membrane) but a chemical reaction between ZnSO_4 and cane-sugar which leads to the formation of zinc saccharate, and consequently to a diminution of the Zn ions in solu-

tion. Five years later Sumner published his observations that the action of copper salt can be deferred through the addition of cane-sugar, which is of course similar to the observation by Gies and myself. In the case of the antagonization of ZnSO_4 by another electrolyte we are, however, dealing with the action of both electrolytes on the same colloid.

2. Sumner states also that distilled and fresh water are toxic for *Fundulus* and that there exists an antagonism between distilled water and salts for these fish. The fact that a number of *Fundulus* can live a long time (if not indefinitely) in distilled water and that these fish, if they become landlocked, can live indefinitely in fresh water indicates that the distilled or fresh water are not in themselves toxic for these animals but that the toxic effect occasionally (but not always) observed is due to an inconstant or quantitatively varying constituent of the water. This constituent may be a parasite, or it may be a substance given off by the fish itself, *e. g.*, CO_2 . Wasteneys and I have recently found that CO_2 may produce the same changes on the skin and the gills of the fish as those produced by mineral acids; and that, as in the latter case, the etching effects of the CO_2 may be counteracted through the addition of a neutral salt. The beneficial effect of the addition of some salt to the fresh or the distilled water, therefore, indicates that the salt either kills certain parasites contained or developed in the distilled water, or antagonizes the toxic effects of some electrolyte, *e. g.*, carbonic acid, if its concentration exceeds a certain limit, as it possibly did in some or all of Sumner's experiments.

JACQUES LOEB

ROCKEFELLER INSTITUTE

THE PERMEABILITY OF PROTOPLASM TO IONS AND THE THEORY OF ANTAGONISM

EVIDENCE was recently presented which showed¹ that a great variety of salts readily enter living cells and that antagonism between salts may be due to the fact that they mutu-

ally hinder or prevent each other from penetrating the protoplasm.

In these experiments plasmolysis was the criterion of penetration. Plasmolysis shows which salts enter and how rapidly, but does not indicate whether it is the ions or only undissociated molecules which penetrate the cell. To decide this question experiments were performed to test the electrical conductivity of living tissues in various solutions. The results agree in showing most conclusively that ions readily penetrate living protoplasm and that many ions which penetrate quite rapidly in pure solutions may be hindered or prevented from going in by the addition of small amounts of CaCl_2 or other salts.

To obtain reliable results in conductivity experiments material should be used which is not injured by weak currents or by other experimental conditions. It is desirable that the amount of space between the cells be constant so that the current which passes between the cells may be a constant fraction (as small as possible) of that which actually traverses the living protoplasm. The current should pass through a large number of thin sheets of living tissue, separated by thin films of solution. The penetration of various ions may then be studied by merely changing the solution. If the material is in thin sheets the ions are forced by the alternating current to pass in and out of a great extent of protoplasmic surface; this is of great importance, since the larger the surface the more reliable the measurement. The sheets of living tissue should be sufficiently rigid to permit manipulation and to endure without injury pressure sufficient to pack them firmly together so that the films of solution which separate them may be as thin as possible.

All these conditions are admirably fulfilled by the common kelps of the Atlantic coast (species of *Laminaria*). This material was accordingly used throughout the investigations.

Disks about 13 mm. in diameter were cut from the fronds by means of a cork-borer (the average thickness of the frond was about 0.5 mm.). From 100 to 200 of these disks

¹ SCIENCE, N. S., 34: 187, 1911.

were packed together (like a roll of coins) into a solid cylinder from 50 mm. to 100 mm. long. They were firmly held in place by glass rods arranged to make a hollow cylinder which closely fitted over the outside of the solid cylinder of tissue. Spaces between the rods allowed free access of the solution to the living tissue. At each end of the cylinder of tissue was placed a block of hard rubber containing a platinum electrode covered with platinum black; by means of a screw these blocks could be pressed with considerable force against the opposite ends of the cylinder of living tissue. The only substances which came into contact with the solution were hard rubber, glass, the electrodes and the living tissue. Details of construction will be given in a subsequent paper.

The current after leaving the electrodes traversed the solution for a very short distance and then passed directly into the living tissue. The same solution which bathed the electrodes was also present between the disks of living tissue in the form of thin films. The surface in and out of which ions were forced by the current amounted to from 26,500 to 53,000 sq. mm.

The measurements were made in the usual manner by means of a Wheatstone bridge. The solutions were brought to the same temperature before measuring except that in the case of small deviations the proper correction was made.

The usual method of procedure was to place the cylinder of disks in the solution, clamp the electrode carriers firmly against both ends of it, lift it out of the solution and read the resistance as soon as the superfluous liquid had drained from the tissue.

A preliminary series of experiments showed that the material remained to an extraordinary degree uninjured by the action of the currents employed as well as by the additional treatment involved in the experiments. In the first experiments the material was usually left immersed in sea water in the apparatus for 24 hours. During this period 12 readings were taken (the current passing for about two minutes each time) and the disks were

12 times taken out and then replaced in the apparatus. At the end of the 24 hours the resistance to the current remained unchanged (if injury had occurred the resistance would have been diminished) and there was no indication either macroscopic or microscopic that the cells were injured.

If the plasma membrane and the cell wall presented no obstacle to the passage of ions we should expect the resistance of a cylinder of living tissue to be practically that of a similar cylinder full of sea water. It was found that a cylinder of living tissue had a resistance of 1,100 ohms (all the figures given in this paper refer to readings taken between 18° C. and 18.2° C.) while that of a cylinder of sea water of equal size was 320 ohms. To ascertain whether this excess of resistance was due to living protoplasm or to cell walls the protoplasm was killed by adding sufficient formalin to the sea water to make a 2 per cent. solution. In other experiments the disks were killed by careful drying. In all cases the resistance after killing fell to about 320 ohms. These experiments demonstrated in the clearest manner that the ions penetrated very much less rapidly into living cells than into dead protoplasm or into cell walls.

Experiments were then made to determine the rate of penetration of various ions. As the treatment was the same in all cases it will suffice to describe a typical experiment dealing with NaCl and CaCl₂.

The material was first tested in sea water and found to have a resistance of 1,100 ohms. After remaining four hours in sea water the resistance was unchanged. The material was then transferred to NaCl .52 *M* which had the same temperature as the sea water and the same conductivity (as determined by numerous careful tests). The electrode carriers were unclamped and moved apart. Each disk was then seized in turn by the forceps and moved back and forth in the solution so as to wash out the sea water and replace it by the solution of pure NaCl. This was repeated several times. It was thus possible to rinse each disk thoroughly in the solution without removing it from the apparatus or changing

its position in the series of disks which composed the cylinder. The mere act of rinsing the disks in this way and then reclamping the electrodes made only slight changes in the reading.

After remaining five minutes in NaCl .52 *M* the resistance had dropped to 1,000 ohms; after ten minutes to 890 ohms; after fifteen minutes to 780 ohms; after sixty minutes to 420 ohms. It continued to fall steadily until it reached 320 ohms, at which point it remained stationary; it then had practically the conductivity of sea water. On replacing in sea water it did not recover any of its resistance, even after standing for several days. It should be noted that the solution of NaCl employed is nearly isotonic with sea water and that none of the observed effects could be due to osmotic action.

Further experiments showed that if the material was removed from NaCl solution and placed in sea water as soon as its resistance had fallen about one hundred ohms below the original resistance it quickly regained its original resistance and remained unchanged for a long time.

It is therefore evident that pure NaCl produces a very rapid decrease in resistance which, up to a certain point, is reversible.

A very striking contrast is obtained by placing living tissue in a solution of CaCl_2 having the same conductivity as sea water. The resistance then rises rapidly to a maximum (very often in the first fifteen minutes from 1,100 ohms to 1,750 ohms) and remains practically stationary for some hours. After this it slowly sinks and finally reaches about 320 ohms, which is the resistance of an equal amount of sea water. If, however, it be returned to sea water shortly after it has reached its maximum it soon regains its original resistance and remains for a long time (in sea water) practically unchanged. The rise in resistance caused by CaCl_2 is in no way due to its action on the cell walls, for dead tissue shows no rise.

It is therefore evident that CaCl_2 produces a very rapid *increase* in resistance, which is reversible.

What is the effect of combining NaCl and CaCl_2 in the proportions in which they exist in sea water? This question has great theoretical and practical interest in view of the fact that CaCl_2 is known to antagonize the toxic action of NaCl in the most striking way. To answer this question the following experiment was performed. To 1,000 c.c. NaCl 1 *M* there was added 15 c.c. CaCl_2 1 *M*; the mixture was then diluted until it had the same conductivity as sea water. On placing living tissue in this mixture it neither gained nor lost in resistance and even after twenty-four hours had the same resistance as at the start.

It is therefore evident that the entrance of the ions of NaCl is greatly hindered by the presence of very small amounts of CaCl_2 and that this may explain the antagonistic action of CaCl_2 on NaCl.

Further experiments showed that such salts as KCl, MgCl_2 , CsCl, RbCl, LiCl, NH_4Cl , NaBr, NaI, NaNO_3 , Na_2SO_4 , and Na-acetate act in general like NaCl (though with different degrees of rapidity) while BaCl_2 and SrCl_2 act like CaCl_2 .

It might be supposed that some of these effects are due to expansion or contraction of the cells under the influence of the salts, but microscopic observation showed that this was not the case except only that when a cell is injured by the salt a contraction (which I have elsewhere called false plasmolysis) may take place. But as the fall in resistance is already great before any such contraction begins and as the contraction is in any case too small to account for more than a small per cent. of the decrease in resistance it may be regarded as at best a secondary factor which is absent until the resistance has reached a low point and which is almost negligible beyond that point.

It might be supposed that the change in resistance is due to causes which operate in the interior of the cell rather than in the plasma membrane, but this is opposed to a variety of evidence which can not be discussed here.

Two hypotheses may be formed regarding

the increase of resistance which is observed when the tissue is transferred from $\text{NaCl} + \text{CaCl}_2$ to pure CaCl_2 of the same conductivity. On one hypothesis the plasma membrane would retain its normal properties after the transfer but would show increased resistance because it is normally less permeable to the ions of CaCl_2 than to the ions of NaCl .

On the other hypothesis the plasma membrane would suffer a change in its properties as the result of the transfer. The facts strongly favor this hypothesis. I will mention only a few. Visible changes in the outer layer of the protoplasm are produced by CaCl_2 (and many other substances) and this makes it probable that the plasma membrane suffers change. Alum, which is known to alter the properties of many colloids (*e. g.*, in tanning), when added in solid form to the sea water greatly increases the resistance of the protoplasm although it greatly decreases the resistance of the sea water. In this case the only explanation is that the permeability of the plasma membrane is altered. On the other hand it is clear that the large number of substances which produce irreversible decrease of resistance must also alter the plasma membrane.

It seems probable therefore that a great variety of substances alter the plasma membrane so as to increase or decrease its permeability.

It may be pointed out that these results are precisely what should be expected if the antagonistic action of salts is due, as Loeb has suggested, to the fact that they hinder each other from penetrating the protoplasm. It is quite clear from the experiments that CaCl_2 , SrCl_2 and BaCl_2 in small amounts are able to hinder very greatly the entrance of the ions of NaCl . The mechanism of this action is not fully understood, but I may state that CaCl_2 , BaCl_2 and SrCl_2 bring about visible changes in the plasma membrane which are entirely different from those produced by such salts as NaCl . It is hoped that a further study of these visible changes may throw light on this question.

Previous experiments on plasmolysis have

shown essentially similar phenomena and the complete confirmation of the results of one method by those of the other form the most striking proof possible of the facts outlined above.

It may be asked how merely delaying the entrance of a salt can protect the protoplasm against its toxic action. In this connection it may be pertinent to recall the familiar phenomenon of colloid chemistry that a salt which produces marked effects when added suddenly may produce little or no effect when added slowly. It should be noted that there is good evidence to show that the NaCl does not enter the cell alone but is accompanied by CaCl_2 . It is possible that these salts may wholly prevent each other from penetrating internal membranes (*e. g.*, the nuclear membrane) which are of importance in this connection.

The chief conclusions are as follows:

1. Quantitative studies of permeability may be made by a simple and accurate method.
2. Slight changes in the rate of penetration may be observed and accurately measured at very brief intervals.
3. A great variety of anions and cations readily penetrate living protoplasm.
4. Inasmuch as these ions are insoluble in lipid it would appear that Overton's theory of permeability can not be correct.
5. The plasma membrane is readily altered by a variety of substances in a fashion which is easily understood on the hypothesis of a colloid (probably proteid) plasma membrane but which can not be explained on the hypothesis that the plasma membrane is a lipid.
6. The antagonistic action of salts is largely or entirely due to the fact that they hinder or prevent one another from entering the protoplasm.

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NOTES ON THE DISTRIBUTION OF THE SOUTHEASTERN SALAMANDERS (*GEOMYS TUZA* AND ALLIES)

A CHARACTERISTIC feature of many parts of the pine forests of the coastal plain of Georgia,

Alabama and Florida is the common occurrence of small mounds of sand a foot or more in diameter and a few inches high, scattered irregularly over the surface or in more or less evident lines, and usually several feet apart. A traveler from farther northeast, seeing these mounds for the first time, might easily imagine that some one had been driving along with a wagon-load of sand and dumping it out in large shovelfuls. They are seen best in winter and spring, partly because the surrounding vegetation is less conspicuous then, and partly for other reasons.

These diminutive mounds cover the outlets of the burrows of a subterranean rodent, *Geomys Tuza*, which is known throughout its range as the "salamander."¹ (Zoologists have divided the original *G. Tuza* into some half-dozen species and subspecies, but there are no wider gaps between the ranges of the different forms than there are between some colonies of the same species, and they all have essentially the same habits and habitat, so that for the purposes of this discussion it will be most convenient to treat the group as a unit.) The animal feeds on roots, travels entirely underground, as far as known, and very rarely shows itself, in the daytime at least.

While working for the Florida State Geological Survey in 1908-1910 I had occasion to visit every county and to travel on nearly every railroad in that state; and on railroad journeys I usually had nothing better to do than look out of the car-window and make notes on the topography, vegetation and other geographical features. The salamander hills, which certainly constitute one of the topographic features, even if a very insignificant

¹ Dr. C. Hart Merriam in his elaborate monograph of *Geomys* and related genera ("N. Am. Fauna No. 8," p. 112, 1895) characterized this common name as "singularly inappropriate and misleading." But contrary opinions as to its appropriateness have been expressed by Goode (Powell's Report on Colorado River, p. 281, 1875) and Bangs (*Proc. Bost. Soc. Nat. Hist.*, 28, p. 175, 1898); and it is no more misleading than the names cypress, cedar, sycamore and poplar, applied to very different trees in this country from what they are in the old world.

one, thus received their share of attention, and in that way I have accumulated records of hundreds of precise localities for this elusive animal. On plotting these on a map recently some interesting correlations between them and certain other geographical features became evident. In previous years I had visited every county in Georgia and Alabama in which *Geomys* is known, but my notes on its distribution in these two states are much less complete than they are for Florida.

In both Georgia and Alabama the salamander ranges all the way across the coastal plain up to the fall-line, in about latitude 33° 15', but one can travel many miles without seeing any evidences of it, and it is much less abundant in those states and in west Florida than it is in peninsular Florida. The Biological Survey of the U. S. Department of Agriculture has a record² of just one station for it outside of the coastal plain, namely, near Chipley, Georgia.³ In Alabama the only known stations for it north of the latitude of Montgomery seem to be around Kingston, in Autauga County; in the northeastern corner of Hale County; on high pine hills near Lock 14 on the Warrior River, and between Brookwood and Searles. At both of the last-named stations, which are in the upper (northeastern) part of Tuscaloosa County, the salamander hills are found over Carboniferous rocks, but always where there is a thin layer of some unconsolidated coastal plain deposit, presumably the Lafayette, on the surface.

In Florida salamander hills can be seen in abundance at frequent intervals all the way down to a point between Nocatee and Fort Ogden in DeSoto County, about latitude 27° 10', which is about fifty miles farther south than the southernmost station for *Geomys* mentioned by Outram Bangs in his interesting paper on the land mammals of

² Unpublished, but communicated to me by Mr. A. H. Howell.

³ There happens to be also a Chipley in Florida, a more important place than the one in Georgia, and it is barely possible that the specimen in question came from Florida and was ascribed to Georgia by a slip of the pen.

peninsular Florida.* I have seen them in every county in that state except Franklin, Manatee, Lee, Osceola, Brevard, St. Lucie, Palm Beach, Dade and Monroe, all of which were included by Dr. Eugene A. Smith, in his classical paper on the geography of Florida,⁶ in what he called the "pitch-pine, treeless and alluvial region." These counties are all in south Florida with the exception of Franklin, which is in middle and west Florida, over 200 miles from the rest. Dr. Smith admitted that this was not a very homogeneous area, but he grouped these counties together for convenience because they produced almost no cotton (only two bales being reported from that whole area in 1880). The distribution of *Geomys* now furnishes an additional character for distinguishing these counties from the remainder of the state; for I have seen salamander hills in every county included by Dr. Smith in his other two regions, namely, the "long-leaf pine region," and the "oak, hickory and pine upland region." (The counties in Florida are of course more numerous now than they were at the time of the Tenth Census, but it so happens that that does not affect the truth of this statement.)

About a year ago, in a report on the peat deposits of Florida,⁷ the writer divided the state provisionally into fourteen geographical divisions. Of these the lime-sink region and the lake region, near the axis of the peninsula, seem to be the headquarters of the salamander. The animal is not known at all in the East Coast strip or the coast region of West Florida, both of which consist chiefly of modern (active) dunes next to the ocean and ancient (fixed) dunes a little farther back. It occurs in varying degrees of abundance in the remaining divisions, except those south of the latitude of Lake Okeechobee.

* *Proc. Bost. Soc. Nat. Hist.*, 28, p. 176, 1898.

⁶ Tenth Census U. S., 6, pp. 175-257, 1884. This monograph, like those on other southeastern states in the same volume, bears the entirely too modest designation of a report on cotton production.

⁷ *Ann. Rep. Fla. Geol. Surv.*, 3, pp. 201-375, pls. 16-28, January, 1911.

The range of the southeastern salamander⁸ seems to terminate abruptly on the east at the Savannah River, and on the west at the Warrior and the streams which under two or three other names connect that river with the Gulf of Mexico. From all accounts it appears that the various subspecies (or species as some regard them) of this group, which are the only representatives of the genus east of the Wabash River and its continuations, nowhere occupy the same territory, but are separated by rivers, which must be almost impassable barriers to an animal which spends its life underground and has no use for water. Indeed it is difficult to imagine how such an animal could ever have crossed any of the large rivers which extend all the way across the coastal plain; but at some time in the past the ancestors of the present salamanders must have crossed at least three such rivers, namely, the Altamaha, Apalachicola and Alabama. (The crossing of the Mississippi and Ohio rivers by members of the genus must have taken place at a much more remote period, judging from the much greater geographical and phylogenetic gap between the species on opposite sides of these rivers.) Mr. Bangs, in his paper already cited, expressed the opinion that *G. Floridanus* is separated from the other forms by the St. Mary's and Suwannee rivers, with Okefinokee Swamp connecting their headwaters. If this is true then the salamanders of middle Florida (*i. e.*, that part of the state between the Suwannee and Apalachicola rivers) must be typical *G. Tuza*, the same as in Georgia. However that may be, salamander hills of exactly identical appearance can be found within a mile or two of each other on opposite sides of the Suwannee, which has almost no swamps where it passes through the lime-sink region.

So much for the areal distribution of our salamander. Some interesting correlations

⁸ According to Dr. Merriam's monograph previously cited, *Geomys Tuza* and its near relatives are confined to the three states already named, but the same common name is also applied to another species which inhabits Arkansas and Louisiana.

between it and certain soils and other environmental factors can now be made. Its hills are almost always in dry sandy loam,* presumably of Pliocene or Pleistocene age. It avoids on the one hand the fertile limestone and clay soils which characterize some parts of the coastal plain, and on the other the hopelessly sterile sands of the shifting dunes along the coast and the "scrub" of the Florida peninsula. It is most abundant in regions where according to the statistical maps in the fifth and sixth volumes of the Tenth Census less than one acre to the square mile was cultivated in cotton in 1880; but in soils which at the present stage of the economic development of the southeastern United States are being appropriated by farmers most rapidly. Being confined to dry soil, it is absent from land which is too damp for cultivation by ordinary methods (as well as that which is too sterile or too rocky). But I have never heard any complaints about its interfering with agricultural operations.

The southeastern salamander seems to be invariably associated with the long-leaf pine (*Pinus palustris*), and it may derive part of its food from the roots of that useful tree. The only known station in the Piedmont region of Georgia, mentioned above, is probably not right in the city of Chipley, but very likely on the Pine Mountains near by, where the rocks and soil are pretty sandy, and long-leaf pine abounds.⁹ The range of our animal is by no means coextensive with that of the long-leaf pine, though, for the tree ranges from Virginia to Texas, as well as considerably farther inland in Georgia and Alabama and a little farther south in Florida than the salamander does. Two other trees usually found in the vicinity of salamander hills, and

having more nearly the same range, are two scrubby oaks, *Quercus Catesbaei* and *Q. cinerea*. Mr. Bangs (*op. cit.*, p. 180) states that Cumberland Island, Georgia, is the only one of the sea-islands (which fringe the coast from about Charleston to Jacksonville) on which a *Geomys* occurs. It is also, to the best of my knowledge and belief, the only one which has *Pinus palustris* and *Quercus Catesbaei* on it; and its geological history must have been somewhat different from that of the others.

Lastly there are some interesting relations between the salamander and forest fires, as was noticed briefly long ago in the papers cited in the first footnote.¹⁰ Every long-leaf pine forest, without exception, is periodically swept by fire, which burns off the dead herbage and keeps down the underbrush, but does no harm to sound pine trees after they get beyond a certain age. (In prehistoric times these fires, presumably set by lightning, probably did not visit any one spot oftener than once in four or five years, on the average; but now so many fires are set accidentally or purposely by man that few of these forests escape fire longer than a year or two at a time.)¹¹ The dunes and scrub of Florida, mentioned above, as well as the other extreme, the rich hammocks, have so little herbage that fires are very rare, and in such places there are neither long-leaf pines nor salamanders.

Fires in the southern pine woods are most frequent in late winter and early spring, and the salamanders seem to be most active just about that time. The locality near Lock 14 on the Warrior River, when first discovered on April 15, 1911, had evidently been burned over a few days or weeks previously, and the salamander hills there looked pretty fresh. What is still more interesting, none could be found in precisely similar areas near by

*At the northernmost Alabama stations there is a considerable admixture of gravel in the soil, and it is possible that if specimens could be obtained from these somewhat isolated localities they might be found to differ perceptibly in some characters from the only form at present known in that state, *G. Tusa Mobilensis*.

⁹See *Bull. Torrey Bot. Club*, 36, pp. 585-586, 1909.

¹⁰The same relation was noticed still earlier by Sir Charles Lyell, the English geologist, in Screven County, Georgia, in the winter of 1841-42. ("Travels in North America," Vol. I., p. 161, 1845.)

¹¹In this connection, see *Bull. Torrey Bot. Club*, 38, p. 522, 1911.

which had not been burned recently. The locality was revisited in May and June, during which time there were no more fires, and the salamander hills were gradually settling down and disappearing, no new ones having been made in the interval, apparently.¹² It would be very interesting to know if the related species of the middle northwest, *G. bursarius*,¹³ shows a similar reaction to prairie fires.

ROLAND M. HARPER

THE AMERICAN MATHEMATICAL SOCIETY

THE eighteenth winter meeting of the society was held at Columbia University on Wednesday and Thursday, December 27-28, 1911, the program occupying two sessions on each day. The total attendance was about seventy-five, including sixty-three members. President H. B. Fine occupied the chair, being relieved by ex-President H. S. White. The following new members were admitted: Professor Ida Barney, Rollins College; Professor Louis Brand, University of Cincinnati; Professor C. W. Cobb, Amherst College; Professor J. C. Fitterer, University of Wyoming; Mr. G. H. Graves, Columbia University; Dr. Solomon Lefschetz, University of Nebraska; Mr. G. H. Light, Purdue University; Mr. E. S. Palmer, Rutgers College; Professor E. R. Smith, Pennsylvania State College. Eight applications for membership were received. The total membership of the society is now 669, an increase of 27 during the past year.

On Wednesday evening forty-two of the members gathered at the annual dinner at the Murray Hill Hotel. These informal dinners have long been recognized as one of the most attractive features of the meetings.

The treasurer's report shows a balance of \$8,723.89, or deducting outstanding bills, about \$8,200, a slight increase for the year. The income from sales of publications was \$1,513.66. The life membership fund now amounts to \$4,137.17. The number of papers read at all meetings of the year was 180; the total attendance of members was 350. At the annual election 197 votes were cast.

¹² In June Mr. A. H. Howell set traps in several of these hills, but without catching anything, which seems to indicate that the animals were not working near the surface at that time.

¹³ Since Dr. Merriam's monograph some additional notes on the habits of this species have been published by Mr. C. L. Webster in the *American Naturalist*, 31, pp. 114-120, 1897.

The society's library has increased to 3,840 volumes, beside some 500 unbound dissertations.

At the annual election, which closed on Thursday morning, the following officers and other members of the council were chosen: *Vice-presidents*, H. F. Blichfeldt and Henry Taber; *Secretary*, F. N. Cole; *Treasurer*, J. H. Tanner; *Librarian*, D. E. Smith; *Committee of Publication*, F. N. Cole, E. W. Brown and Virgil Snyder; *Members of the Council* (to serve until December, 1914), A. B. Coble, E. W. Davis, Oswald Veblen and E. B. Wilson.

The following papers were read at this meeting: W. M. Smith: "A characterization of isogonal and equitangential trajectories."

C. L. E. Moore: "Surfaces in hyperspace which have a tangent line with three-point contact passing through each point."

J. E. Rowe: "How to find a set of invariants for any rational curve of odd order."

J. E. Rowe: "A covariant point of the K^4 , and a special canonical form."

R. L. Moore: "On the sufficient conditions that an integral equation of the second kind shall have a continuous solution."

E. B. Wilson: "Some mathematical aspects of relativity."

Edward Kasner: "Families of surfaces related to an arbitrary deformation of space."

H. B. Phillips and C. L. E. Moore: "Algebra of plane projective geometry."

Anna L. Van Benschoten: "Products of quadratic inversions and linear transformations in space" (preliminary report).

Arthur Ranum: " N -dimensional spreads generated by ∞^2 flats."

O. E. Glenn: "Generalizations of a theorem on reducible quantics, due to Eisenstein."

F. R. Sharpe: "Finite groups of birational transformations in the plane."

John Eiesland: "On a flat spread-sphere geometry in an odd dimensional space."

C. N. Moore: "The summability of the double Fourier series, with applications."

S. E. Slocum: "A general formula for torsional deflection."

G. A. Miller: "Groups which contain a given number of operators whose orders are powers of the same prime."

R. G. D. Richardson: "Theorems of oscillation for three self-adjoint linear differential equations of the second order with three parameters."

L. A. Howland: "Points of undulation of algebraic curves."

C. N. Haskins: "Note on certain selective integrals."

L. P. Eisenhart: "Ruled surfaces with isotropic generators."

J. W. Young: "On algebras defined by groups of transformations."

J. W. Young: "A generalization to 3-space and to n -space of the inversion geometry in a plane" (preliminary communication).

L. L. Silverman: "On absolute or unconditional summability."

L. L. Silverman: "Tests for Cesàro summability."

W. B. Fite: "Note on a collineation group in n variables."

L. P. Eisenhart: "Congruences of minimal lines in a four-space."

The Chicago Section of the society met at the University of Chicago on December 29-30. The next meeting of the society will be held at Columbia University on February 24.

F. N. COLE,
Secretary

THE AMERICAN PHILOSOPHICAL ASSOCIATION

THE American Philosophical Association held its eleventh annual meeting at Harvard University, Cambridge, on December 27, 28 and 29, 1911. The meeting was marked by an unusually large attendance and by keen interest in the proceedings. A majority of the papers read centered around two main subjects selected for discussion, the one on the relation of object and consciousness in sense perception, the other on evolution. The discussion of the first subject was characterized by a departure from the method of previous meetings. This year both the papers read and the subsequent discussion were based on a carefully prepared committee report, in which both tentative definitions and an analysis of the problem were made. While this method did not result in an agreement of any great extent, it served to clarify the problem and to bring to a sharper focus the various issues involved in it. The committee which prepared this report was continued and given power to select the problem for next year, to formulate the issues involved in it, and to arrange for the discussion. Three papers and the presidential address were read on the subject of evolution, and these as well as the other papers read received vigorous discussion. The association empowered the executive committee to arrange, if possible, some future meetings with other societies in order that joint sessions may be held to dis-

cuss such questions as that of mechanism and vitalism.

E. G. SPAULDING,
Secretary

THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

THE 24th annual meeting of the American Association of Economic Entomologists was held in the new National Museum, Washington, December 27-29. The meeting was called to order on Wednesday afternoon, December 27, and after the routine business of opening the session was disposed of the annual address entitled "The Relation of the Economic Entomologist to His Environment" was delivered by the president, F. L. Washburn, state entomologist of Minnesota.

On the following day papers were read at morning and afternoon sessions, and on Friday morning, at the close of several interesting papers, the final business of the session was transacted and the meeting adjourned.

The report of the secretary showed that the membership of the association had increased slightly during the year of 1911, and at the meeting over forty new members were admitted. This makes the total membership of the association, exclusive of foreign members, more than three hundred, and the interest shown in the association, especially by the younger members, augurs well for its future success.

Among the more important business matters that were transacted was an arrangement whereby the official organ of the association, the *Journal of Economic Entomology*, will, in the future, be published by the association instead of by the publishing company, as heretofore. The present editorial board will serve for the coming year, with the exception of the business manager of the *Journal*, Professor E. D. Sanderson, Morgantown, West Virginia, who voluntarily retired. The management of the *Journal* has been placed in the hands of the secretary of the association.

The following officers were elected:

President—W. D. Hunter, Dallas, Texas.

First Vice-president—T. J. Headlee, Manhattan, Kansas.

Second Vice-president—R. A. Cooley, Bozeman, Montana.

Secretary—A. F. Burgess, Melrose Highlands, Mass.

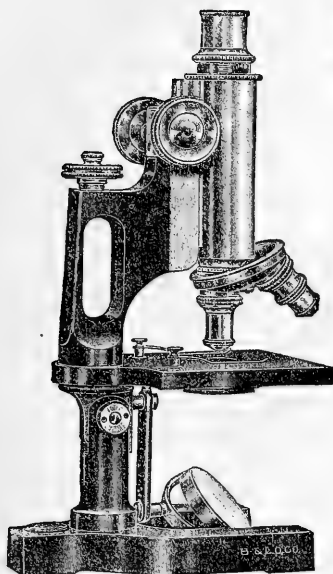
A full account of the business transacted at the meeting together with the papers read with the discussions will be published in the *Journal of Economic Entomology*, the first number of which for the current year will be issued February 15.

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SCIENCE

FRIDAY, JANUARY 26, 1912

AN EARLY PHYSICAL CHEMIST—M. W. LOMONOSOFF¹

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At the present day, it seldom happens that due credit is not given to each chemist for any new facts which he may add to the sum of chemical knowledge and, conversely, it is usually an easy matter to attach to any given fact the name of the investigator who first discovered it. For reasons which, in part, at least, are obvious, these conditions are not always so easy to fulfil in the case of the fathers of the science. It is certain, at all events, that frequently recognition has here been long delayed and, even where the most fundamental facts are concerned, the determination of the parentage has had repeatedly to be revised.

At the very start, there is difficulty in settling what constitutes *discovery*. Scheele's preparation of oxygen undoubtedly took place a year or two before Priestley's, but his publication of the results was delayed until three years after Priestley's, and priority in discovery is generally held to require priority in publication.

Again, Paracelsus obtained what is now known as hydrogen by the action of iron filings upon vinegar, but Cavendish defined the substance by its properties, and so the discovery dates from 1766. Liebig prepared bromine, but set the sample aside, believing it to be a chloride of iodine, and Balard, who prepared the substance later, and recognized it to be a new halogen, became the discoverer. Similarly, a

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

¹Presidential address, delivered before the American Chemical Society at Washington, December 28, 1911.

hundred years before Priestley's time, Borch (1678) prepared what is now known as oxygen in large quantities by heating saltpeter, but he failed to ascertain any of its properties; and again, forty-five years before Priestley's experiment, Hales collected the gas from the same source over water (the first record of any attempt to collect a gas in this way) and obtained, by measurement, 97 per cent. of the theoretical amount. But Priestley, on August 1, 1774, liberated it from mercuric oxide. A lighted candle happened to be standing before him at the moment. By pure chance, as he himself says, and without any particular reason which he could afterwards recall, he immersed the candle in the gas and found that the combustion was unusually brilliant! He thus ascertained one distinct property of the substance and became the discoverer of oxygen. True, he thought at first that it was a compound of nitrous acid, earth and phlogiston, and only in the light of the views of Lavoisier and others, and after long delay, did he accept in 1786 the conclusion that it was an elementary substance. It may be noted that, although Scheele was a better experimenter, his idea of the nature of oxygen was not much clearer. He thought that fire-air (oxygen) united with phlogiston to give heat, and that the last was a compound of the first two. Evidently, in those days, isolating the substance, and defining one or two of its properties, together conferred discoverer's rights, no matter how grotesquely the nature of the substance was misunderstood.

I say "in those days," for Curie made several compounds of radium, establishing their relations to one another, and is justly held to be the "discoverer of radium," although no isolation of the element was attempted. Now that the science has developed, isolation can be dispensed with,

and, in point of fact, was omitted in most of the exploratory work amongst the rare metals. If this principle could have been applicable in earlier days, several of the decisions of chemical history might have been reversed. A hundred years before Priestley's time, Mayow (1669) had shown by conclusive experiments that atmospheric air was made up of two components, of which the active one formed twenty-five per cent. of the whole. In measuring the amount, he employed the same reaction subsequently used by Priestley, namely, removal of the oxygen by the introduction of nitric oxide and absorption of the product in water. But whereas Priestley was thereby estimating the "goodness" of the air, and had no idea that he was dealing with a mixture, Mayow was perfectly clear as to the interpretation of the results. The latter demonstrated that the same component was removed in combustion, by rusting metals, by the alcohol in vinegar-making and by the blood in respiration. He traced the animal heat of the body to a process analogous to that which heated the mass when marcasite rusted in the air. He identified this active component of the air as a constituent of saltpeter, and particularly of the acid part of this substance, and (like Lavoisier more than a century later) held that it was contained in all acids. Finally, he considered it to be an element, in the modern sense of the word. Unfortunately circumstances conspired to relegate to obscurity all his wonderful work and magnificently clear reasoning. Mayow was a young physician, and the divergent view-point of Boyle, as an older man and an eminent philosopher, received more attention. Again, the logical conclusiveness of Mayow's proof of the existence of oxygen as a distinct substance, was entirely over the heads of his contemporaries, and his way of thinking quite out of

harmony with theirs. In this point of view, he came a century and a half too soon. Such a proof, if offered at the present day, would be accepted as conclusive. The final isolation of the element would now be considered a matter of mere routine, that could be assigned to a beginner in research, as the basis of his dissertation for the degree of doctor of philosophy. Finally, the clouds of the phlogistic theory soon began to darken the sky of the science, and before long the spread of this remarkable notion, diligently fostered by Stahl, who had been born nine years before the appearance of Mayow's work, enveloped chemistry and the whole chemical world in an impenetrable fog. Since the believers in phlogiston started always with one absurd idea as the major premise, namely, that, in combustion and oxidation, some kind of matter *left* the burning or rusting material, the more rigorous the logic of the subsequent steps in the reasoning, the more certain was the attainment of uniformly false conclusions. The inveterate phlogistian, and everybody down to the time of Lavoisier, not excluding Priestley and Scheele, was forthwith an inveterate phlogistian, saw in simple, almost modern modes of thought, like those of Mayow, only the sheerest nonsense. If we all stood habitually upon our heads, naturally any one caught persisting in a tendency to view the universe in the normal way would be instantly adjudged insane. For these various reasons, Mayow's work was first neglected and then forgotten.

The story of Mayow suggests some additional conditions which determine the recognition of a discoverer, and the acceptance of his discovery. How often in the history of science has a dominating but conservative personality diverted attention from younger or less prominent men, or at the least, by hostile criticism, delayed the

acceptance of their ideas. The discoverer who occupies a conspicuous social position is, often, more readily detected. Then again, for the dealing of strict justice, the consequences may be almost as unfortunate when the discoverer is a century ahead of his time, like Mayow, as when he is three years late, like Scheele. And, finally, an intellectual plague like the phlogistic theory may be epidemic. An infection runs until a milder generation of the infecting organism is gradually evolved, or until the presence of the organism results in physiological changes which automatically give rise to substances that destroy it. Lavoisier was fortunate in arriving upon the scene when the disease was ready to loosen its hold. It was not that his fundamental experiments, upon the subject of air and oxygen, were new—the same conclusions could have been reached by putting together the work of his predecessors and contemporaries. It was largely because of his personality, and because he arrived at the psychological moment.

I have prefaced my address in this way, in order to furnish a setting for its subject. He lived from 1711 to 1765. He thus was educated, did his life-work, and died in the most virulent period of the phlogistic epidemic. Heat, light and weight were then forms of matter, yet, when he notices them at all, he combats these views, and makes experiments to disprove them. In a day when the jargon of the phlogistian was the only language of polite intercourse amongst chemists, he speaks and writes the language of modern chemistry—of the most modern chemistry, for he was a physical chemist. Needless to say, he lived at a time far removed from the psychological moment for a man holding such a viewpoint. Naturally, credit for his discoveries, and they were many, has all been distributed amongst others. It is quite

likely that some of you have never happened to hear his name—the name of Michael Wassiliewitsch Lomonosoff.

Even in Russia, although his work in literary and linguistic lines, his success as a man of affairs and his investigations as a geographer and a meteorologist had won for him enduring fame, the fact that he was primarily a chemist had been completely forgotten. It was Menschutkin² who, a few years ago, rediscovered him as a chemist, reprinted in Russian his scattered memoirs and collected all that could be found of his manuscripts, letters and laboratory note-books.

Although trained—chiefly in Germany—by, and along with, men who ardently supported the current views, he seems with astonishing ease to have thrown off the prejudices of his contemporaries, and to have achieved a perfectly independent view-point of his own. At that time, the emission of light-matter explained the phenomena of light. Largely through the enormous influence of Newton's selection of the emission theory in preference to the wave theory (first developed by Huygens in 1690), this remained the accepted explanation until after a hard struggle against the influence of Laplace (1817) and others, who were unconvinced, with the explanation of the phenomenon of polarization by Fresnel, the ether-wave theory finally triumphed. But Lomonosoff discusses (1753–56) the possible motions of ether—progressive, rotatory and wave-like—identifies the last as the basis of light, and goes in great detail into the nature of ether, and the properties of light-waves and the mode of their propagation.

In Lomonosoff's day, heat was also a

form of matter. The classical experiment of Rumford was made (1798) thirty years after his death. But, so strong was the prejudice, that, even then, the proof (by quantitative experiments) that heat could be generated without limit from friction, under conditions such that the addition of any substance or form of matter was impossible, did not carry conviction. Lavoisier believed (with some hesitation, it is true) in an imponderable *matière de chaleur*. It was not until after the work of Mayer (1842), who was at first persecuted for his views, and especially after the demonstration by Joule (1855–60) that heat and work were mutually and quantitatively inter-convertible, that the theory that heat was matter finally disappeared. Yet Lomonosoff, more than a century earlier (1744–47), in a paper on "The causes of Heat and Cold," discusses in detail the experimental evidence that motion is a source of heat, and that molecular motions are caused by heating. Radiant heat, of which then little was known, was transmitted by motions of the ether, which he believed to be of the rotatory variety. In all his papers, heat is always a mode of molecular motion. The paper named was the subject of vigorous discussion, particularly in Germany, and, after the views contained in it had been sufficiently abused, they were consigned to oblivion.

The kinetic-molecular theory of gases used to be attributed to Krönig (1856) and Clausius (1857). But Lord Rayleigh discovered in the archives of the Royal Society a very complete form of it, contributed by Waterston in 1845. The state of public opinion among physicists, even then, a century after Lomonosoff's work, may be judged from the fact that the committee of the society considered the content of the paper to be nonsensical, and refused to permit its public presentation. Lomo-

²"M. W. Lomonosoff, as a Physical Chemist," St. Petersburg, 1904. See also an article by Menschutkin, *Annalen der Naturphilosophie*, 4, 203.

nossoff's paper, read before the Academy of St. Petersburg in 1744, nearly suffered the same fate, for it was withheld from publication for three years. Starting with the view of Daniel Bernoulli (1738), to the effect that the pressure of gases was due to the impacts of their particles, Lomonossoff proceeded to develop ideas very much like those now held. According to him, for example, a rise in temperature caused increased motion of the particles, and resulted therefore in increased pressure. His theory differs from ours mainly in the fact that rotatory motions played a large part, and that the molecules had rough surfaces. Incidentally he points out that there is no limit to the possible amount of motion, and therefore no maximum of temperature, but that there is a minimum of motion, when the latter becomes zero, and there must therefore be a minimum of temperature. In a later paper (1750) he proves by his hypothesis that the pressure *should* be, as it was then known to be, inversely proportional to the volume. And he goes further, for, with surprising insight, he shows that, with increasing pressure, this relation will no longer hold, since the volumes of the particles themselves are not diminished. The reputed discoverer of this consequence of the theory is Dupré (who was thus anticipated by 115 years), and in 1873 Van der Waals finally put the same fact into definite form.

In all this, it must not be supposed that Lomonossoff was simply a reasoner, much less a speculator. The discussion is loaded with a wealth of experimental facts, many of them ascertained by himself. It is especially noteworthy, also, that his experiments, almost without exception, were quantitative. When we remember that the balance is a stubborn instrument, and that its evidence always went contrary to the conclusions of those who pinned their faith

to heat-matter and phlogiston, we perceive how completely his habits of work and attitude of mind were out of harmony with those of his contemporaries, and how startlingly independent were his modern ways of experimenting and reasoning.

Before turning to the part of his work that was more especially of a chemical and physico-chemical nature, a few words about his career may be of interest. He was born of peasant parents—Russian peasant parents of the early eighteenth century—about the year 1711, and in a village forty-five miles from Archangel. Opportunities for education there were none. Finally, at the age of nineteen, he reversed the procedure of the typical boy, and ran away, to go to school. At 24, he left the school in Moscow to attend the lectures of the professors in the Academy of Sciences in St. Petersburg. At twenty-five he was sent on a traveling scholarship to Marburg, where he studied chemistry under Wolff. After three years, he went to Freiberg, and two years later he returned to St. Petersburg. In both places, when he moved, the academy had to pay the debts that he had incurred! Upon his return home, he became adjunct professor at a salary of \$900, but the academy, being poor in money, paid its professors largely by gifts of copies of its publications, a sort of product for which there is an almost infinitesimally slow market. A year later, we find him in the university, lecturing in Latin on chemistry, geography and the Russian language. Lecturing in Latin upon the Russian language to Russian students! Such simple, blind devotion to a tradition surprises us—even when it occurs in a university. His active experimental work as a chemist began in 1744, when he was thirty-three years of age, and in 1845 he was appointed to the professorship of chemistry.

After three years of planning, a chemical laboratory was built, and on the 12th of October, 1748, it was opened. The building, a modest one, measured 45×36 feet, and was divided into a large room for work and two small rooms for lectures and storage. It cost \$4,000, and about \$1,800 additional was spent on furnaces and other equipment. Thus, in providing a place for laboratory instruction, as well as for research in chemistry, Lomonosoff was fifty years ahead of Hope in Glasgow and seventy-five years ahead of Liebig.

Lomonosoff's period of greatest chemical activity was compressed into the nine years that followed the opening of the laboratory, for in 1757 he resigned his chair. During the remaining eight years of his life the numerous activities of a public man, and a diversion of his interests into other scientific lines, interfered with chemical work.

Up to the end of the eighteenth century, there was utter confusion of thought in regard to the composition of materials. In considering the make-up of a specimen, and the changes occurring during an experiment, heat-matter, light-matter and weight-matter, as well as phlogiston, were taken into account. As we have seen, even Scheele interpreted the phenomena he observed upon the theory that heat was an oxide of phlogiston! The composition was often stated in terms of salt, sulphur and mercury, whether there was evidence of their presence or not. The "elements" of Aristotle, and cognate ideas, were used in describing and in thinking about chemical phenomena. In consequence, Priestley thought he had a method of measuring the "goodness" of air—as a quality—when in point of fact he was measuring the amount of oxygen—as a component. With the basal conceptions thus in a state of utter chaos, it is no wonder that the simplest

chemical situations were wholly misunderstood, and that the simplest experimental results, being described in terms of non-existent entities, and thought of in terms of non-existent relations, failed of their object. It was Lavoisier who received the credit for setting our ideas permanently in order, by his emphasis upon the significance of the evidence of the balance, and by his setting forth clearly the idea of chemical compounds and their component elementary substances, and by giving a classified list of the latter.

The chemical reformation might have come half a century sooner, however, if Lomonosoff's papers had been more widely known. As we have seen, to him heat and light were not forms of matter and phlogiston had no existence. His forms of matter were the same as ours, and his ideas of chemical composition, what it included and what it excluded, the same as ours. In his "Elements of Mathematical Chemistry"³ (1741), and in a later paper "On the Imperceptible Physical Particles, which Compose Natural Materials, and in which is to be found a Sufficient Basis for the Specific Properties" (1742-43), he gives a singularly clear and minute discussion of the whole subject. He distinguishes between the attributes (weight, volume, etc.) of a body or specimen, and the specific properties which characterize a substance. In modern fashion, he defines the "imperceptible particles" or "corpuscles" (molecules), which are portions of a substance, and the "physical monads" or "elements" (atoms) which are not decomposed in chemical change. He draws clearly and in detail the distinction between simple and compound substances, the latter of which contains the "prin-

³ This and parts of others of his papers are published, in German translation, in Ostwald's *Klassiker*, 178.

cupia" (elementary forms of matter) in chemical combination. The explanations are in experimental, and not obscure, theoretical terms.

In the paper on "Heat and Cold" (1744-47) he refers to Boyle's experiment, in which lead was sealed up in a retort and heated, when the lead and calx, upon removal, were found to have increased in weight. According to Boyle, this result showed that the heat, which alone could enter through the glass, had weight. Lomonosoff, of course, will not accept this conclusion and points out that the increase in weight of metals when heated in air must be due to union with material from the air, just as their increase in weight when placed in the flame of burning sulphur is due to union with "acid" from the sulphur. Later, in 1756, he repeats Boyle's experiment, and finds that, until the retort is opened and air rushes in, no increase in weight is observable. He thus performed one of Lavoisier's most fundamental and convincing experiments eighteen years in advance, and interpreted it correctly. It is apparent that Lomonosoff's sound views were based upon many quantitative experiments on combustion, although the laboratory note-books containing the details have not yet been found.

But, if Lomonosoff anticipated Lavoisier in his work upon the chemical relations of the forms of matter, he went far beyond Lavoisier in his views in regard to the uses of mathematics and physics in chemistry, and, in this direction, anticipated many of the points of view of the later nineteenth century. Lomonosoff's unfinished treatise, "The Elements of Mathematical Chemistry" (1741), of which only a fragment survives, deals with a conception which, in all his writings, he never ceased to urge, namely, the value of mathematical methods in chemistry. Ten

years later, in an "Address on the Uses of Chemistry" (1751), he speaks as follows:

If chemistry unites to solid form the separated and scattered particles in a solution, and brings forth various formations, it must be that she relies upon the strictest and most highly developed Geometry. . . . If she changes solids into liquids and liquids into solids, and divides and unites them to give various substances, it must be that she seeks counsel of the most exact and ingenious Mechanics. If chemistry, by union of different substances, gives rise to different colors, she needs the help of the most profound Optics. . . . If the knowledge-seeking, tireless investigator [in response to this] will only survey her through geometry, measure her forces by mechanics, and consider her through the science of optics, he will probably reach his desired goal.

In this we seem to see at least an adumbration of chemical crystallography, and of chemical dynamics and statics. He continues:

Why have investigators had no success? I answer that for this a very skillful chemist is needed, who is at the same time a mathematician. Has not the recent development of the science been along the precise lines which he thus lays down?

Lomonosoff's applications of geometry in "De Nitro" (1749), a comprehensive study of saltpeter, will illustrate his own attempts to use mathematical methods. He discusses at length the crystalline form of the substance and proceeds to develop a theory of crystalline structure. In saltpeter, the prismatic form can be accounted for by an arrangement of round particles, in such a way that lines drawn through their centers always form equilateral triangles. In other substances, the arrangement is different, so that, for example, in common salt, the lines through the particles may form squares. As usual, he paid the penalty of being far ahead of his time. Yet he had anticipated by a century the essential conceptions of Bravais (1850), whose mathematical study of all

possible space nets, and their relation to existing crystalline forms, coming at a more favorable time, led almost immediately to the completion of development along this line by Sohneke (1867).

In the same address, he continues:

[The chemist] is surely unapt, who has made a mass of experiments, but, in the effort to secure quickly accessible products, hastens to the attainment of this as his sole goal; he overlooks those phenomena and changes occurring in his operations which might lead to the explanation of nature's secrets.

If this viewpoint, with its contempt for purely preparative chemistry, had been as prominent in the creed of all the chemists of the century and a half since Lomonosoff's time, as it was in his own, instead of being until recently the ideal of only a few scattered chemists, what a different science ours would have been. How many papers, signed by notable names, might have offered something of substantial scientific value, in place of a mass of new entries for the indexes of Beilstein and Dammer. In the preface to his treatise on saltpeter, he develops the same idea:

Since as yet no general physical bases for explaining the formation and composition of chemical substances exist, and since few physical experiments have been applied in chemistry so as to lead to the desired results, it may seem difficult, but we believe it to be possible, scientifically to describe the greater part of chemistry in terms of the interrelations of its own principles and their connections with those of physics. We do not doubt that, after the union of chemical with physical truths, we shall be able more successfully to understand the inner nature of substances.

Be it understood, these generalities are only summaries of the plans of study which, in his experimental work and in his papers, he attempts in thoroughgoing fashion to put into practise. Uttered as they were in the heart of the period of phlogiston, of heat-matter, and of confused experimentation and reasoning, they

have an uncanny sound, and almost terrify us with their supernatural prescience. How long have we had to await the psychological moment for the general application of these ideas! Had only the times been ripe; had only the atmosphere been healthy for the propagation of such ideas as his, instead of being virulently poisonous to them, our science might easily, by now, have been a hundred years ahead of its present position, and we might to-day have been listening to papers which, as it is, will not be read for a century. If Dante's *Divina Commedia* were to be revised by a chemist and brought up to date, the chief change he would make would be the provision of some horrible and revolting torment, calculated to give Stahl his just deserts.

The occasion is not a suitable one for going in detail into the mass of (for that time) novel and suggestive quantitative physico-chemical experiments which occupied Lomonosoff from 1752 to 1756. The extent of his plans—only partially fulfilled—may be judged from his "*Dromus ad veram chymiam physicam*" (Course in true Physical Chemistry, 1752), of which a considerable part was written, and much survives. In the introduction he mentions, amongst other aims of physical chemistry, this:

One must determine the specific properties of every substance as exactly as possible, in order that, after the composition has been ascertained by chemical operations, one may judge whether, and to what extent, each property is altered by changing a given constituent.

No statement of one of the purposes of physical chemistry could be clearer.

In the experimental part of the book, salt solutions receive much attention, and many modern problems may be recognized, such as measurement of exact solubilities at various temperatures, volume changes in solutions, capillary phenomena, action

of electricity upon solutions and relative deliquescent tendencies of salts. There is, of course, a good deal about crystallography. In the absence of the laboratory note-books, only parts of some of the tabulated results have been found. One set of experiments, chiefly with common salt, led to the conclusion that the freezing points of solutions are lower in proportion to the amount of the dissolved body. Even the most insignificant experiments were carried out quantitatively.

In Lomonosoff's laboratory, a good deal of special apparatus was devised. Measurements of the coefficient of expansion of air had been made, and a value (recalculated to 1° C.) of 0.003 (in place of 0.00367) was found. This led to the construction of an air-thermometer for measuring low temperatures. Incidentally, he reformed the Delisle scale of temperatures, which ran downwards from 0° at the boiling point of water to 150° at the freezing point, by simply inverting it (0° L. = 0° C., 150° L. = 100° C.). A thermostat for ice and water was employed in some experiments, and instruments for the study of oceanography, devised by him, came afterwards into general use. One of the most extensive pieces of work done in his laboratory was a study of colored glasses and mosaics, the results of which led to the establishment of a factory, still in successful operation, near St. Petersburg.

The achievements of Lomonosoff outside of chemistry were as remarkable as those within that science. He wrote a treatise on metallurgy, made investigations in meteorology and especially atmospheric electricity, in geology, and in mineralogy, and he assisted in the equipment of expeditions for geographical exploration. He observed the transit of Venus of 1761, and drew from his observations the

conclusion that the planet had an atmosphere "similar to, and perhaps greater than that of the earth," a discovery generally attributed to Schröter and Herschel (1791).

No undertaking that required courage and originality was outside the comprehensive sphere of his interests. He was the first to attempt to apply modern forms to the writing of poetry in the Russian language, and was the author of odes, poems, and even of tragedies to be performed in the Court Theater. He prepared a Russian grammar and a treatise on rhetoric. He devised a vocabulary for expressing scientific conceptions, and his terms are those now in use in Russia. As the most prominent Russian man of science of his time, public affairs claimed much of his strength. Taking him all in all, the rediscovery of Lomonosoff has added at once a chemist of the first magnitude and a personality of marvelous force and range to the limited gallery of the world's very greatest men.

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THE CAUSE OF HIGH PRICES¹*

If the student of present-day affairs should classify the reasons for existing discontent, he would certainly give to the high cost of living a position in the front rank. Dominant political parties, ruling ministries, national policies and local conditions are indiscriminately blamed, yet the phenomenon of high prices is manifest among all progressive nations and in a degree throughout the whole world. It is in evidence in all countries regardless of tariff policy and monetary standards. It is also

¹ Address of the vice-president and chairman of Section I, Washington, 1911.

apparent under all forms of government. If there is any one class of countries in which the phenomenon attracts less attention it is in those which are least advanced in civilization. Obviously many of the causes to which this general rise in prices has been ascribed must be fallacious because of its universal prevalence.

In explaining the causes it is essential to recognize three fundamental facts, very obvious in their nature, but not so readily understood in their bearing upon the present situation:

1. The rapid progress made by leading nations in modern times.

2. The striking inequality of this progress in different branches of human endeavor.

3. The inevitable tendencies in every progressive era to overaction in enterprise and to extravagance and waste in expenditure.

The second and third facts are subordinate or incidental to the first and closely associated with each other. Let us explain the effect of each in its order.

1. Notwithstanding long periods of inertia and even of retrogression, the dominant note in the history of the race has been that of progress; this has been especially true in the last 100 years. Scientific progress has always been in the van, followed by material, intellectual and political progress. Science has given to mankind a constantly increasing control over nature. Inventions and discoveries have greatly multiplied the supply of useful articles adapted to satisfy human wants. As a result, the convenience and luxuries of one generation are regarded as necessities in the next. One marked effect of this progress is the alleviation of the struggle for existence, with the resulting leisure or opportunity to acquire greater skill and to discover new methods of production. The

requirement of less effort for obtaining the necessities of life gives a wider scope to human enterprise and makes it possible to multiply the achievements which contribute to the betterment of the race.

Nothing is more apparent than that the average per capita consumption is constantly increasing, not merely in essential food products, but in a variety of useful articles which are now available for more general use. Some tables prepared by the late Professor Richmond Mayo-Smith set forth clearly the increased consumption of divers articles in several countries of Europe in periods of 20 to 25 years:

ANNUAL CONSUMPTION PER CAPITA IN DIFFERENT COUNTRIES IN DIFFERENT YEARS

Article and country	Date	Date	Increase Per Cent.
Meat, France	25.9 kilos	33 kilos	27.41
	1868	1890	
Meat, England.....	100.5 kilos	124.5 kilos	23.88
	1871-75	1891-95	
Tea, Germany.....	.02 kilo	.05 kilo	150.00
Petroleum, Germany....	3.75 kilos	14.82 kilos	295.2
	1871	1896	
Flour, United Kingdom.	150 lbs.	257 lbs.	71.33
Tea, United Kingdom...	3.91 lbs.	5.77 lbs.	47.57
Eggs, United Kingdom.	12.6	40	217.46
Butter and margarine...	4.7 lbs.	11.1 lbs.	136.17
Cocoa .....	.23 lb.	.62 lb.	169.56
Bacon and ham.....	3.4 lbs.	15.9 lbs.	367.64
Refined sugar.....	5.23 lbs.	41.53 lbs.	686.55

It may be noted that modern means of communication, the ready transmission of news and the increasing scope of industrial and commercial operations have brought about a solidarity of interest among nations and rendered it easy to obtain by international trade useful articles even from the remotest parts of the earth. These same forces have promoted political progress, the assertion of popular rights and a greater equality of opportunity. One effect of this has been that wealth and the consequent increase of average consumption are no longer limited to a few.

The development of a more peaceful disposition among nations has caused a great increase in both production and consumption. Human effort has been less occupied with warfare and more with the development and utilization of the world's resources. All these factors make possible a rising standard of living which increases prices, unless there is equal progress in the various branches of production.

2. Progress, however, has been notably unequal in the different branches of endeavor which supply human wants. It is necessary to keep in mind the difference between a rise in the price of certain classes of products and a general rise in the price level, to which reference will be made later. There is a substantial distinction between these two phenomena. New methods in industry and commerce are revolutionizing the means for supplying human wants, but their effect is far more helpful in some categories of products than in others. Whether this be the result of natural conditions or limitations upon our knowledge is not pertinent to this inquiry. The fact is obvious. Throughout all periods, notwithstanding changes in fashion and taste, there has existed a demand amounting to a necessity for certain essential products, such as food, clothing and shelter. It is evident that science, working through inventions and improved methods, has not accomplished the same results in agriculture, especially in producing food supplies, as in manufacture. The revolution in industrial methods and in the utilization of capital in large scale operations has not been accompanied by equal progress on the farm. Very considerable progress has been made, it is true, in carrying agricultural products to the market and in preserving them for use, but these pertain to transportation and to the middleman rather than to the original producer. Accord-

ingly, as we should expect, the prices of farm products have risen much more rapidly than the prices of manufactured articles. In a very valuable report of the Chief of the Bureau of Statistics for the Department of Agriculture for the year 1910, a comparison is made between the increase in the prices of articles purchased by farmers during the ten years from 1899 to 1909 and the increase in the value per acre of that which the farmers sell. For the articles purchased the average increase was 12.1 per cent., while the average rate of increase in the value per acre of that which the farmer sells was 72.7 per cent., or six times as much. The comparison is made even more emphatic when it is noted that among the articles purchased by farmers flour and lard show maximum, or nearly maximum, increase in prices in response to the higher prices obtained for wheat and hogs. To this rise in the price of articles of food there is one general exception, namely, the price of tropical or semi-tropical products, most of which show a decrease for reasons which do not exist in the case of products of the temperate zone.

The rise in the prices of agricultural products in the temperate zones is well illustrated in the case of raw materials used in the manufacture of clothing. Until this present year the price of cotton had shown a steady increase. The price of middling cotton per pound in the year 1895 was 7.44 cents in the New York market; in 1903 it was 11.18 cents; in 1910, 15.11 cents, or twice as much as fifteen years before. The price of fine wool in the month of January, 1895—for most of which year there was no duty—was in the eastern markets $17\frac{1}{2}$ cents; in 1903, 30 cents, and in 1910, 36 cents. It may be added that cotton and woolen cloth in their various forms show a much less increase in

price than the raw products from which they are made.

The same general facts are true with relation to cereals and all other food products of the temperate zones. A cause additional to the lesser degree of assistance from invention may be found in the greater scarcity of land suitable for profitable cultivation and in our own country especially the early cultivation of fertile areas was conducted with too much regard for immediate returns and consequently little attention was paid to permanent productive quality. It is of course plain that farm products as well as all articles show an increased price by reason of the greater cost of wages and of most of the supplies which farmers must use. This, however, is common to all branches of production.

The unequal development in different lines of production has of late become especially noticeable in the case of precious metals. Formerly success or failure in gold or silver mining was largely a matter of chance. Now, however, as a result of the discoveries and improvements in engineering, and much more in chemistry, gold or silver mining has assumed the position of a settled industry in which calculations of the profitableness of treating certain ores or digging along a lode may be made with a fair degree of certainty. It may be added that improvements in production are unequal not only as regards different classes of useful articles, but also for different articles of substantially the same class. This is true of various lines of manufacture, hardly any two of which have been affected in the same degree. The manifest effect of this inequality in the ease or difficulty of production is a change in their relative value.

3. There is an inevitable tendency toward overaction, misdirected energy, waste and extravagance in every progressive era.

This tendency has its roots in the very characteristics of human nature itself. It is due in part to the measure of uncertainty which pertains to all business undertakings and in part to the ambitions and dispositions of men. Whenever a new process is invented for satisfying a human want or a new market is discovered, it is probable that the inviting prospect of gain will cause an undue amount of investment and effort in that new direction, which results in a loss of capital and an over-supply of certain articles. The tendency to waste and extravagance is even more marked in the utilization of new facilities or the purchase of articles which please the taste or fancy. It is a well-known fact that the desire for the automobile has caused many persons to invest in this new luxury who could not afford it. A new style of house, or equipage, or of dress, all of which are common in a time of increasing wealth often lead to the discarding of that which under less favorable circumstances would be regarded as sufficient and to the purchase of other articles in accordance with present-day tastes or fashions. Social ambitions and the desire for luxury tend in the same direction; extravagance grows as facilities and attractive articles multiply. Along with these factors is the desire for ease and luxury which accompanies the accumulation of wealth. This is but a result of the fact that pleasure is more attractive than pain; that enjoyment is preferred to effort, hence the number of the unemployed increases and the amount of effort made for satisfying human wants diminishes.

An important factor of the present situation affecting the high cost of living is the rapidly growing cost of government, national, state and municipal. In case the proceeds derived from taxation are applied to essential improvements naturally no

waste would accrue, but there are nevertheless substantial differences between public and private enterprise. The former is managed with a less degree of care and supervision. Given a certain object, the expense of securing it by public management is usually greater than under private control. There is a still more important factor. The aim and nature of public expenditures differ materially from private investments. The latter are made with a view to an adequate return, a profitable income on the amount expended; in many instances, the former look to objects of a less essential nature, sometimes to monuments of grandeur or of art, which do not subserve any immediate purpose of utility. Public activities are often undertaken for conserving health or maintaining more perfect order and have in view considerations of general welfare most commendable in their nature, but such as would not be initiated in expectation of immediate profit. Again, they oftentimes provide for new facilities on a scale which private enterprise would not attempt. To all these must be added—and especial attention is called to this—the enormous burden of military and naval armaments now amounting, in the more civilized nations, to two billions per year, an economic waste which imposes an almost unendurable burden upon the world's resources. Again in prosperous times a disposition to indulge in excess and unwise undertakings is constantly manifest both in public and private expenditures. So long as there are limitations upon our ability to forecast the future, this will be true. No more helpful consummation in commerce and industry could be wished than that which by careful weighing of future needs and probabilities could adjust present activity to future demand.

In this connection it must be stated that

the inequality of the supplies of raw material requisite for human needs is a prominent factor in the situation. The lumber supply of the United States, which at one time seemed abundant and even inexhaustible, in view of the great demand for buildings, furniture, implements, etc., has been diminished to such an extent as to threaten an early exhaustion. Perhaps the wisest policy would have suggested that the state limit the cutting of timber and require that new forests be planted. However that may be, the diminishing supply of timber in the face of unusual demand has caused a rapid increase in the price of products of the forest, the advance from 1900 to 1910 being the greatest of any single class. A comparison of the figures prepared by the Bureau of Commerce and Labor shows that between 1900 and 1910 the wholesale prices of wooden ware and furniture increased about 20 per cent., while the prices of window glass and grades of earthenware decreased nearly as much. For this divergence there is an evident explanation, namely, that the supply of timber is becoming more scanty while that of sand and clay and other materials for glass and earthenware is inexhaustible and readily available.

There have been numerous illustrations of the increase in prices in the history of progressive countries. According to Boeckh, in the time of Solon an ox in Athens cost 5 drachmas, or nearly 3 shillings, a sheep 1 drachma, a bushel and 3 gallons of corn 1 drachma. Two hundred years later the prices rose to five times and in many cases to ten or twenty times their former amount. The quantity of money was increased by the spoil obtained by successful military operations and by the development of mining in the islands of the Mediterranean, in Attica itself, and in Thrace and the island of Thesos. In

Rome it is more difficult to trace the changes in prices of food. Corn was sometimes exacted as a tribute from conquered countries and sold by the state at less than cost and occasionally given away. The increase of prices was particularly rapid after the concentration of the chief mining industry in the hands of the Roman government. Cattle increased in price as well as corn. About 400 B.C. sheep sold for 7 pence, 3 farthings. At the date of the Christian era the price was 25 shillings. After the Carthaginian wars the Romans acquired the valuable mines of their enemies in the western part of Africa, also in Sicily, Sardinia and the south of Spain. A few years later the mines of Greece and Asia Minor came into the possession of the Romans; still later the mines of Macedonia and Thrace. In their later conquest, special effort was made to acquire supplies of precious metal.

In the year 1581 a dialogue was printed, attributed to one "W. S.," probably William Smith, entitled "A Discourse of the Common Weal of this Realm of England." The participants in the dialogue are a knight or owner of land, supposed to be Mr. Thomas Hales, a doctor of divinity, who, as it is conjectured, was Bishop Hugh Latimer, a husbandman, a tenant farmer, a merchant, a mercer and a capper. An enterprising publisher in the year 1751 republished this dialogue and basing the authorship on the initials "W. S." assigned it to William Shakespeare, a manifest effort to obtain a greater sale by deceit. The real date of the dialogue as appears from more recent investigation was the year 1549. This document is exceedingly valuable for students who are considering the subject of high prices, for if we leave out the influence of the larger aggregations of capital, and the characteristic features of modern business, practically every rea-

son for a rise in prices is advanced in it. Each ascribed to the occupation of the other the responsibility for the existing situation. Views are expressed upon the benefits of protective tariffs against foreign products, upon the balance of trade, upon the exactions of the middleman, upon the increase in rents of agricultural land. One of the characters expresses the opinion that avarice is the cause of high prices. Another mentions the great increase in the cost of necessary articles. One of them says: "Within these 8 years you could buy the best pig or goose that I could lay my hands upon for 4 pence which now costs me 8 pence and a good capon for 3 pence or 4, a chicken for a penny, a hen for two which will now cost me double the money, and it is likewise of great ware as of mutton and of beef." It was maintained in this discussion that price determined rent and not rent price. The husbandman conceded that if he were commanded to sell his wheat and other products at the old price he would have enough to pay his landlord as in times past, but he says that he must buy iron, salt, tar and pitch, all of which brought a higher price than formerly. One cause of the increase of prices, which is pointed out in this dialogue, is the clipping of coin which caused the good coins to go abroad for use in foreign trade. There were, however, more universal causes than this. Bodin, a French political philosopher, of the last half of the sixteenth century, states as an undoubted fact that there had been a revolution in prices. He gives six reasons for it:

1. The great abundance of gold and silver which resulted in a decrease in its purchasing power. The discovery of America and the increase of commerce and the development of banks caused the great abundance.

2. The monopolies of the Guilds and of the tax farmers.

3. The ease with which wine and corn—the chief products of France at that time—might be exported, thus increasing the price at home.

4. The extravagance of the Court.

5. The general leisure in the community.

6. The debasement of money, a practise which was prevalent in France at that time.

Mr. Jacob, in his excellent work on "Precious Metals," ascribes the increase in prices, of which complaint was made in the dialogue referred to, to the increased production of the precious metals and traces with great research the coincidence between their increased supply and the high prices of that time. A similar object lesson in the history of prices is derived from a comparatively recent period. In the years from 1789 to 1809, the average price of commodities rose from an index figure of 85 to 157, or more than 80 per cent. There were many contributing causes, such as the prevalence of war and the interference with international trade caused by the French Revolution and the Napoleonic wars. Mr. Tooke lays stress upon the poor harvests of that period, but Professor Jevons ascribes the increase to the larger production of gold and of silver and points out that metals and oils were more affected than grain. Beginning in 1809, for a period of 40 years, prices fell from an index number, as measured by Professor Jevons, of 157 to 64 or nearly 60 per cent. This decrease has been very generally ascribed to the falling off in the production of precious metals which did not revive until the gold discoveries in California and Australia. There was a temporary rise after 1839, apparently due to the inflow of Russian gold following its discovery in Siberia in 1830. The great activity prior

to 1837 was also a contributing cause. It should be carefully borne in mind that this period from 1809 to 1849 was a time of great industrial advancement in which many inventions and improvements were utilized. In the period from 1849 to 1873, prices rose from 64 to 86, or about 33 per cent. The rise was interrupted by the crises of 1857 and 1866 and greatly accelerated by the exceptional activity prior to 1873 and was presumably due to the gold inflation following the development in 1849 in California and several years later in Australia. In the period from 1873 to 1896 prices fell in gold countries and this is ascribed to the decrease in the production of gold, to the adoption of the gold standard in the more advanced nations, thereby discontinuing the general use of one of the precious metals, at least as far as free coinage was concerned.

Manifestly there were other causes for the decrease in prices at this time. The great increase in facilities for transportation, culminating with the opening of the Suez Canal in 1869, brought different portions of the earth nearer to each other and made it possible to utilize the abundance afforded by outlying districts for the benefit of the more settled areas where food products were becoming less abundant. Again there were most notable increases in the mechanical arts. So considerable was this decrease in prices that several writers, of whom perhaps Mr. David A. Wells is the best example, came to the conclusion that the period of the most buoyant activity had come to an end; that thereafter the people would occupy themselves with repair and replacement or in utilizing discoveries already made. In other words, the most profitable production had reached a limit.

A very valuable contribution to the subject of prices is furnished by a comparison

between gold and silver standard countries. In India, where silver was still the money of the people, the index of prices rose from 107 in 1873 to 140 in 1896. In Japan it rose from 104 in 1873 to 133 in 1896, or a little less than 20 per cent., while in gold-using countries prices fell off more than 20 per cent. From 1896 to 1909 there has been a rise in prices contemporaneously with a great increase in the quantity of gold mined in South Africa and in different portions of the United States and Alaska.

Let us draw a little more fully the comparison between these eras of high and low prices and the production of gold. From 1789 to 1810, it has been stated that there was a rise in prices. During these years the average production of gold in the whole world was a little less than \$12,000,000 per year, and that of silver approximately \$37,000,000, or \$49,000,000 in all. Beginning in the year 1811 the annual average for the next ten years was \$7,606,000 of gold or a diminished supply of more than 33 per cent., and \$22,000,000 of silver, a diminished supply of about 40 per cent. In the following decade from 1821 to 1830 there was an increase in the mining of gold and a decrease in that of silver, but the total annual average was slightly less than from 1811 to 1820. From 1831 to 1840 there was a substantial increase in both metals amounting to about 33 per cent. From 1841 to 1850 gold production increased from about \$13,000,000 per year to \$36,000,000. However, in the forty years from 1811 to 1850, inclusive, an era of low prices, the average annual production of gold was barely \$17,000,000 per year; then with the opening of the mines in California and Australia the average suddenly rose from \$17,000,000 to over \$130,000,000, and to a still greater figure from 1856 to 1860. This was a period of

rapidly rising prices. After this there was somewhat of a decrease. The lowest annual production was for the four years, 1874, 1875, 1876 and 1883, in each of which the production was between ninety and a hundred millions. A practically uniform and very large increase commenced in the year 1891 with \$130,000,000, which increased to the enormous figure of \$236,000,000 in 1897, after which with slight interruptions resulting from the Boer war, the still higher figure of \$454,000,000 was reached in 1909. It thus appears that the production for the single year 1909 was more than two thirds as much as for the forty years from 1811 to 1850. It was greater than the combined coinage value of gold and silver for any year prior to 1898 and five times as great as the production of gold in the year 1874.

A further fact to be taken into account, of course, is the relation of the annual increment to the accumulated supply. Divers estimates of the world's stock of gold have been made. That which should be considered is the portion used for money in the form of coin or bars of bullion. At the present time the annual production is equal to at least three and perhaps four per cent. of the total existing monetary supply. Of the \$454,000,000 mined in 1909, it has been estimated that \$145,000,000 was utilized in the arts. It is probable that this is a large estimate, but in any event the primary money of the gold standard countries was increased by \$300,000,000 in the year 1909. Indeed, according to the very carefully prepared estimate of Dr. Roberts, the Director of the Mint, the amount of coinage for that year is given as \$313,000,000.

It is not by the mere addition of gold to the monetary supply that prices are raised. There is an even more important stimulus to activity in the fact that this money is

used as a basis of credit; that countries which heretofore have been without railroads and modern facilities are enabled to borrow for the construction of great railway lines and public works, the full benefit of which is often for a long time postponed. There is a marked increase in the demand for materials for this work. Labor is more constantly employed and at higher wages. The consuming power of the average human being is greatly increased. Speculation is rife and this tends to raise prices.

The connection between the increased supply of the precious metals and the general level of prices has been so marked and has appeared in so great a variety of countries and of periods as to preclude the possibility of mere coincidence. Of course certain modifying factors should be taken into account. The rise in prices after the beginning of the increase in the supply of gold or silver does not become manifest until some time has elapsed. This can be readily explained, because a substantial increase is necessary to modify the relation between the existing stock of the precious metals and the accretions.

Again, there has usually existed a concurrence of factors which make for increased activity and rising standards of living, on the one hand, and the increased supply of the precious metals, on the other. The development of gold mining on a large scale has followed closely after discoveries and inventions. This concurrence is such that while it would hardly be safe to generalize upon it, there is a strong presumption of a connection between the two. A somewhat similar cause of the rise of prices, by reason of the increased supply of gold among the militant countries of the ancient world, may be traced in their activities to secure the control of mines from which the precious metals were obtained.

The foregoing facts emphasize the importance of the so-called quantitative theory of money in considering the question of prices. To give adequate treatment to this theory and to estimate the effect of the volume of money upon prices would prolong this paper to an undue length. It would manifestly be incorrect to state the relation of the volume of money in circulation to the general level of prices as a simple equation. The problem is much more difficult. On this subject Mr. John Stuart Mill wrote in his work on Political Economy:

The proposition respecting the dependence of general prices upon the quantity of money in circulation must be understood as applying only to a state of things in which money—that is, gold or silver—is the exclusive instrument of exchange, and actually passes from hand to hand at every purchase, credit in any of its shapes being unknown. When credit comes into play as a means of purchasing, distinct from money in hand, the connection between prices and the amount of the circulating medium is much less direct and intimate and such connection as does exist no longer admits of so simple a mode of expression.

Certain modifications are necessary in order to harmonize the quantitative theory with modern conditions. Only the amount of money actually in circulation can have any effect upon prices. That hoarded or out of circulation for other reasons can not exert any influence. On the one side, account must be taken of the variations in volume of transactions during periods of prosperity or depression and even at different seasons of the year. This factor affects the demand for the medium of exchange. On the other side, allowance must be made for the rapidity of circulation and the use of credit instruments which reinforce the monetary supply and thereby modify its influence upon the price level.

There are sundry current explanations of the present high prices which may be readily dismissed as untenable if advanced

as a reason for the general rise in the price level, however applicable they may be to the increase in the price of specific articles. What shall be said of the influence of the so-called trusts on prices? It is clear that complete monopoly or preponderant control of the market in the production or sale of any particular commodity affords opportunity to increase its price. The same result is apparent when separate producers maintain an agreement or understanding as to prices.

On the other hand, the superior economy and efficiency of large scale operations materially diminishes the cost of production and even more of distribution and should therefore tend to decrease prices. For this reason the concentration of industrial and commercial enterprise is a legitimate phase of business evolution. It must be said, however, with equal emphasis that thus far the general public has not experienced in reduced prices the benefit to which it is entitled because of the increased economy and efficiency resulting from great combinations. If the people do not receive their proper share of the benefits, strict control beginning with greater publicity and ending perhaps with the regulation of prices is the inevitable outcome. Certain it is that large scale operations have come to stay. If they can not be successfully regulated, it is probable that state ownership will be adopted in preference to a return to the old régime of smaller competing units.

In a majority of cases the statistics of prices do not bear out the assertion that the establishment of large corporations has always caused an exceptional increase in the cost to the consumer. In many instances, the higher prices are due in part at least to the greater expense of obtaining raw materials or to the increased labor and obsolescence charges to which all concerns

of whatever magnitude are alike subjected. In the table prepared by the statistician of the Department of Agriculture, to which reference has been made, it appears that among over eighty enumerated articles purchased by the farmer, there were only three, the cost of which diminished between the years 1899 and 1909. Two of these are comparatively unimportant, the third is coal oil, which fell off from 15.1 cents per gallon in 1899 to 14.2 cents in 1909. There were also substantial reductions in the prices of various forms of iron and steel in the same period, while, as already mentioned, those of practically all the agricultural products of the temperate zone increased.

The rise in the price level can not be ascribed to tariffs any more than to the trusts, though prices of particular articles may have been increased by them. In answer to those who maintain that the tariff is responsible for the high cost of living in the United States, attention may be called to the admitted fact that the rise in the price level has been universal under free trade, as well as under revenue and protective tariffs. In a single newspaper published at Paris last September, there were paragraphs giving accounts of meetings, some of which were attended by violence, in Berlin, Switzerland, Bohemia, Silesia and Galicia to protest against high prices. In other issues at about the same time there were paragraphs giving accounts of bread riots in France and of loud complaints against the high cost of living in England and Belgium.

It is a noticeable fact that many prices have risen in spite of reduced tariffs in our own country, as in the case of hides and shoes. In the whole list of increases in prices from 1899 to March, 1910, there is no more notable illustration than that of crude rubber, on which there is no duty.

The price rose from 80 cents in the former year to \$1.99½ in 1910. On the other hand, raisins and prunes, upon which there is a considerable duty, have shown a material fall, and sugar has not greatly increased in price except very recently, due it is claimed, to crop conditions. Instances might be indefinitely multiplied of the rise and fall of prices here and elsewhere irrespective of the duties levied. These illustrations show that the tariff is only one of the numerous causes affecting relative prices. It may often happen, as in the cases cited, that other causes so far outweigh the influence of the tariff that its effect can not be discerned.

As regards the cost of labor, while a high standard of wages is maintained in the United States and there have been notable increases in the wages of many classes of employees, it can not be said that there has been a disproportionate increase; the facts are quite the contrary because, generally speaking, the cost of living has more than kept pace with the increase in compensation.

As a rule, wages as well as retail prices do not immediately respond to changes as readily as wholesale prices or as rent and other items which make up the ordinary expenses of living. The basic fact which should be considered is the relative proportions of personal service and of improvements accomplished by inventions or labor-saving devices, in the production or distribution of any commodity. In cases in which machinery renders a more efficient service than formerly, the tendency is toward downward prices, but in case labor or personal service has been only partially aided by these improvements, or as in some cases not at all, the prices have increased.

Under modern systems of distribution the amount of personal service required is

relatively much greater than formerly and in this fact may be found a very important cause of high prices. Much more care is exercised in the preparation and handling of packages. Delivery is made to the consumer at his residence. There is no sufficient organization in distribution. As a result there is a vast amount of duplication. This service involves an exceptional cost as compared with the work of distributing large quantities. For example, the carrying of a ton of coal 150 miles to a city costs less than the transfer of that coal for a half or even a quarter of a mile to the home in which it is consumed. The cost of delivery of mail matter by carriers in cities and on rural free delivery routes is much in excess of the carriage in bulk by railway or steamship, even for very long distances.

Innumerable examples may be given of the very considerable difference between the original cost to the manufacturer and the final charge to the consumer. Some weeks since figures were carefully prepared in regard to the manufacture and sale of an article of clothing now in very general use. The manufacturer charged \$24.90 per dozen. Each dozen included different sizes. The retailer charged from \$4 to \$10 per garment. The total sales averaged about \$6.50 for each, or a total of \$78 to the consumer as against \$24.90 to the manufacturer. The retailer is not to be blamed. The pressure of population in cities, the greater demands of modern life resulting in higher rents and higher cost for services rendered to him, make it essential that he should charge more for the goods he sells.

An entire revolution in methods of distribution is imminent. The consumer will be brought nearer to the producer. Great warehouses will be substituted for small and scattered shops, especially in case of

staple articles where confidence in the seller or exceptional skill are not essential features. The possible economy of large-scale production and the undertaking by one organization of the various processes, even from the raw material through manufacture and distribution to the consumer, has been demonstrated by some of the great corporations of the country. However much we may decry this tendency, we may be reasonably certain that it will be adopted more and more in the future.

It would be rash to predict an early return to low prices. All the great factors which I have partially portrayed depend upon new conditions which have arisen, some of which are inseparably connected with substantial benefits to the human race. If prices have increased, human enjoyment has increased also.

That which is most noticeable in the consideration of this problem is the wide variation in the changing cost of divers commodities and facilities. After making due allowance, however, for this variation, there is a manifest increase in the general price level. Great economic laws will be potent in their effect upon these conditions. The enormous increase in the production of gold will be checked as this metal becomes less valuable in comparison with useful articles. Indeed, this fact is already forecast by the diminished annual increase in the years 1910 and 1911. The increasing price of farm products may stimulate a "back to the farm" movement, but whether this proves true or not it will undoubtedly encourage more scientific methods of cultivation and thus increase the average yield per acre. More intelligent and more adequate control will be exercised over great industrial and commercial organizations so that the benefit of modern developments in industry and

commerce may accrue in proper measure to all classes of consumers.

The same advances which have been made in production and in the distribution of great masses of commodities will, as far as possible, be applied to the minutest details of distribution. Our natural resources which have been wasted, or too largely absorbed by the few, will be more carefully utilized and every possible means be taken to preserve a proper share of them for the future. Thus in this present increase of prices as in all great economic changes there may be reasonable assurance that the ultimate effect will bring to all substantial benefit rather than harm.

T. E. BURTON

*THE CENTENARY OF THE ACADEMY OF
NATURAL SCIENCES OF PHILADELPHIA*

EARLY in the past year resolutions were adopted by the council of the Academy of Natural Sciences of Philadelphia approving of a fitting celebration of the centenary of the society on the nineteenth, twentieth and twenty-first of next March. The president appointed a committee of forty-one to make arrangements for such celebration.

The general committee, of which the president, Samuel G. Dixon, M.D., LL.D., is chairman, has been divided into sub-committees on printing and publications, meetings and addresses, invitations, finance and entertainment. In harmony with a preliminary report of this committee the publication of three volumes has been decided upon: A commemorative quarto volume of scientific memoirs, adequately illustrated; an index to the series of *Proceedings and Journal* up to and including 1910, now amounting to nearly one hundred volumes, and a detailed history of the academy by Dr. Nolan, of which the chapter contributed by him in 1908 to the "Founders' Week Memorial Volume" may be considered a prodromus. The last mentioned volume will be illustrated by portraits and views.

It has been decided to hold the first session on the meeting night of the academy, on

March 19, when delegates will be received and historical addresses will probably be delivered; two morning sessions will be devoted to the reading of scientific papers by members, correspondents and delegates; on the afternoon of the second day a microscopical exhibition will be given and the resources of the academy demonstrated; on the evening of that day a reception will be tendered by the president to members, guests and friends; and the proceedings will end with a banquet on the evening of March 21, the official birthday, of the academy.

The preparation of the proposed publications is progressing satisfactorily and the dignity and importance of the commemorative volume is assured. It is hoped that a united effort may be made to secure for the occasion a success commensurate with its importance in the history of the academy and in its relation to the advancement of science in America.

SCIENTIFIC NOTES AND NEWS

DR. FREDERIC A. LUCAS, director of the American Museum of Natural History, has been made a corresponding member of the Zoological Society of London.

DR. AUGUST WEISMANN, professor of zoology in the University of Freiburg, will retire in April.

DR. GEORGE B. SHATTUCK has retired from the active editorial management of the *Boston Medical and Surgical Journal* after a service of thirty-one years.

We learn from the *Journal* of the American Medical Association that Professor Theodor Ziehen, director of the psychiatric and neurologic clinic in Berlin, will resign his position at the end of the winter semester and discontinue all medical work, in order to devote himself exclusively to research in psychology. For this purpose, he will remove to Wiesbaden, where he will erect for himself a private psychological laboratory.

PROFESSOR ARMIN BALTZER, Berne, and Dr. Emmanuel de Margerie, Paris, have been elected foreign members and Professor Charles Depéret, Lyons, and Professor Arvid Gustaf

Högbom, Upsala, have been elected foreign correspondents of the Geological Society of London.

M. LECLAINCHE, professor in the veterinary school at Toulouse, has been elected a corresponding member of the Paris Academy of Sciences, in the section of agriculture.

At the ordinary scientific meeting of the London Chemical Society on December 21, 1911, it was announced that the council had awarded the Longstaff medal for 1912 to Dr. H. Brereton Baker, F.R.S.

At the dinner of the Western Society of Engineers, Chicago, on January 10, announcement was made of the award of the Octave Chanute Medal for 1910 in electrical engineering to Mr. H. B. Gear, general inspector of the Commonwealth Edison Company, Chicago, for his work on "devices for the distribution of electric light and power." Mr. C. P. Berg received the medal for mechanical engineering in the heat treatment of high-speed tools, and Mr. C. K. Mohler was awarded the medal in civil engineering for his studies of earth pressures.

THE Institution of Mining and Metallurgy of Great Britain has awarded gold medals as follows: Gold Medal of the Institution (two awards): (a) to Mr. E. P. Mathewson, M.Inst.M.M., general manager of the Anaconda Copper Company, Arizona, in recognition of his services in the advancement of metallurgy generally, and especially in regard to copper; (b) to Mr. Walter McDermott, M.Inst.M.M., in recognition of his services in the equipment of the Bessemer Laboratory of the Royal School of Mines and as the representative of the institution on the Board of Governors of the Imperial College of Science and Technology during the period of its establishment and organization; and to signalize his services in the advancement of metallurgical practise. The Consolidated Gold Fields of South Africa (Limited) Gold Medal to Mr. Walford R. Dowling, M.Inst.M.M., for his paper on "The Amalgamation of Gold in Banket Ore."

PROFESSOR H. W. RILEY, head of the de-

partment of farm mechanics of the College of Agriculture of Cornell University, was elected president of the American Association of Agricultural Engineers at the annual convention recently held at St. Paul, Minn.

At the meeting of the American Society of Bio-chemists, held in Baltimore, the following officers were elected: *president*, Dr. Archibald B. Macallum, University of Toronto; *secretary*, Dr. A. N. Richards, University of Pennsylvania; *treasurer*, Dr. Walter Jones, Johns Hopkins University; *councilors*, Drs. L. B. Mendel, Yale, and H. Gideon Wells, University of Chicago.

DR. EDWARD G. DEXTER, of Illinois, has been renominated by President Taft to be commissioner of education for Porto Rico.

MR. J. C. TH. UPHOF, of Amsterdam, author of "Die Pflanzengattungen," has been appointed gardener for the Botanical Garden at the Michigan Agricultural College. He will also do work in connection with the herbarium. He is expected to enter upon his duties in the latter part of February.

PROFESSOR THEODORE PFEIFFER, of Breslau, has declined a call to the directorship of the Agricultural Experiment Station, Möckern, near Leipzig.

MR. N. C. NELSON, instructor in anthropology in the University of California, has been appointed assistant curator in the department of anthropology, American Museum of Natural History. He will assume his duties next June and will give especial attention to North American archeology. Mr. George Borup, who was in charge of the third supporting party of Admiral Peary in his last polar expedition, has been appointed assistant curator in the department of geology and invertebrate paleontology.

DR. WEBER has been appointed director of the imperial health office, Berlin, to succeed Professor Uhlenhuth, who is at present director of the hygienic institute at Strasburg.

DR. ERWIN ERHARDT, of the University of Munich, is visiting the United States to study methods of treating cancer.

DR. L. A. BAUER has returned to Washing-

ton after a nine months' trip of inspection of the magnetic work being conducted, under the auspices of the Carnegie Institution of Washington, on board the *Carnegie* in the Indian and Pacific oceans and by land expeditions in Australia and Asia. *En route* he also visited the various magnetic institutions in the Pacific Islands, New Zealand, Australia, India, Burma, Java, China and Japan, and observed the total solar eclipse of April 28 at Tau Island of the Manua group.

The Auk states that Mr. Roy C. Andrews, assistant curator of mammalogy in the American Museum of Natural History, sailed for Korea on December 13. He expects to spend about two months at the whaling stations there, for the purpose of studying and securing specimens of the California gray whale and humpbacked whale. He then plans a trip into the mountains of northern Korea, known as Chokaku San, where about four months will be spent in collecting mammals and birds, if possible in regions not hitherto visited by zoologists.

MR. WALTER GRANGER, associate curator of fossil mammals in the American Museum of Natural History, is abroad engaged in part upon researches among the fossil mammals of the English and French museums, especially the old world relatives of the four-toed horse.

At the third lecture in a series on biological topics being given before Trinity College Frederic S. Lee, Dalton professor of physiology, College of Physicians and Surgeons, New York, exhibited, for the first time in this country, cinematograph films representing phases of muscular action, such as the reaction of the perfused heart to various agents, ciliary and flagellate motions in *Trypanosoma*, etc.

CAPTAIN H. G. LYONS, F.R.S., late director of the Egyptian Survey, will give a course of lectures before the Royal Geographical Society on February 9, 13 and 16 on the North African Desert.

A PORTRAIT of the late Dr. John Ashhurst, Jr., has been presented to the College of Physicians, Philadelphia.

DR. JEAN BAPTISTE EDUARD BORNET, the algologist, member of the Paris Academy of Sciences, has died at the age of eighty-two years.

THE death is announced of William Thynne Lynn, former assistant at the Royal Observatory at Greenwich, at the age of seventy-six years.

DR. JAN. KOWALEZYK, astronomer in the observatory at Warsaw, has died at the age of seventy-eight years.

M. ARTHUR DE CLAPARÈDE, the geographer, has died at Geneva, at the age of fifty-nine years.

THE sixth triennial congress of the International Association for Testing Materials will be held in the Engineering Societies building, New York, beginning on September 3, 1912.

A JOINT meeting of the British Institution of Mining and Metallurgy and the Canadian Mining Institute will be held at Toronto on March 6, and the following days.

THE *Bulletin* of the American Mathematical society states that a new journal, entitled the *Vector* has been established at Warsaw. It will be devoted to mathematical and physical science in general and especially to questions of method and pedagogy.

Nature states that the council of the London School of Tropical Medicine has decided to establish a journal in connection with the school. Three parts are to appear each year, and part I. has just been issued. Sir Patrick Manson writes a foreword; original papers are contributed by Drs. Bayon, Daniels, Hutton, Leiper, Minett and Wise; and surveys of recent literature on tropical medicine and reviews of books complete the matter.

UNIVERSITY AND EDUCATIONAL NEWS

THE will of the late Mrs. Emily Howe Hitchcock provides that the Hitchcock mansion and the estate of forty-five acres, valued at \$50,000, shall go to Dartmouth College. To the college is also left Mr. Hitchcock's Di Cesuela collection of Cyprus antiquities. To the Mary Hitchcock Memorial Hospital, con-

nected with Dartmouth, is left an endowment fund of \$20,000, and to the Howe Library of Hanover, occupying the ancestral home of Mrs. Hitchcock, an endowment of \$50,000. To the Pine Park Association, a society formed to preserve the natural beauties of the town, is bequeathed a large tract of woodland adjoining the Vale of Tempe.

THE Marquise Arconati Visconti has given 500,000 francs to the faculties of science and arts of the University of Paris.

DURING commencement week, June 23 to 27, inclusive, the University of Michigan will celebrate the seventy-fifth anniversary of its founding.

CIRCULARS of information concerning the Kahn foundation for the foreign travel of American teachers have been issued by the trustees of the foundation. Two fellows will be appointed for one year beginning July 1, 1912, with a stipend of \$3,000 and an additional \$300 for the purchase of books, souvenirs, photographs, etc. The applications for appointment should be made on a formal blank which may be obtained from the secretary of the foundation, Sub-station 84, New York City, and should be filed on or before March 1, 1912. The present holders of the fellowships are Professor J. H. T. McPherson, of the University of Georgia, and Professor Francis Daniels, of Wabash College. They both sailed from this country during the summer and will have completed their year's travel by about August 1, 1912. They are both planning to make a complete trip around the world.

THE course on "Water Analysis and Water Supply" at the Rensselaer Polytechnic Institute has been expanded so as to allow of a preliminary course being given on "plankton" where special attention is devoted to those growths which produce taste and smell in reservoir water. Upon the completion of the above water course, each student is required to spend two weeks at work on local municipal slow sand filter beds and also on filters of mechanical type whereby he acquires a practical knowledge of the workings of full-

sized city filter plants. The cities in the neighborhood of Troy supply good illustrations of the different modern methods of water purification.

The *Bulletin* of the American Mathematical Society states that during the Easter vacation of 1912 an extensive course in mathematics and physics for advanced teachers will be held at Göttingen under the direction of Professor F. Klein.

DR. C. RANKIÄR has been appointed professor of botany, and director of the Botanical Gardens at Copenhagen.

DR. GILBERT T. MORGAN, assistant professor of chemistry at the Imperial College of Science and Technology, South Kensington, and junior hon. secretary of the Chemical Society, has been appointed to the chair of chemistry at the Royal College of Science, Dublin, vacant by the retirement of Sir Walter Noel Hartley, F.R.S.

DR. THEODOR BOVERI, professor of zoology at Würzburg, has been called to Freiburg.

DISCUSSION AND CORRESPONDENCE

NUMBER OF STUDENTS PER TEACHER

TO THE EDITOR OF SCIENCE: It appears to me that the only correct way to determine the average number of students handled per teacher in any school is to divide the number of student hours per week by the number of teacher hours per week.

For example, let there be 15 teachers and 300 students. This does not mean that on the average one teacher instructs 20 students in a recitation or class. Suppose each student takes 15 hours per week, and that each teacher instructs only 12 hours per week. There are therefore 15×12 classes per week for 300×15 students, since each student appears in 15 classes. The average number of students in each class is therefore

$$300 \times 15 \div 15 \times 12 = 25.$$

In general, therefore, the average number of students which each instructor has to handle in one recitation is the number of student hours divided by the number of teacher hours, in one week.

The average number of hours per week re-

quired of each student and each teacher, viz., the number of student-hours and teacher-hours per week divided respectively by the number of students and teachers, are also important numbers in respect to the average work required of students and teachers.

ARTHUR S. HATHAWAY

ROSE POLYTECHNIC INSTITUTE

FUNDULUS AND FRESH WATER

"*Fundulus* and Fresh Water" in your issue of December 29, 1911, recalls some experiences I have had with these fishes in transferring them from salt and brackish to fresh water. *Fundulus heteroclitus* may be so transferred more safely, the less degree of salinity there is in the water whence they were derived. Most of my specimens came from the Hackensack River and its creeks, varying from the saline Newark Bay to the almost entirely fresh water at Little Ferry and at the heads of the creeks. While very few of those transferred from salt water directly to fresh survived the sudden change, an increasing number survived of those gradually transferred in the course of a week or two, through a number of changes of water. My records show that such fishes lived from four to six months, up to two years; one lived over three years. I never succeeded, however, in making a successful transfer of the highly colored breeding males.

Fundulus diaphanus, though known almost entirely as a fresh water species, when taken from salt water also offers difficulties in transferring, thus showing that successful transfer in all cases appears to be a matter of very gradual accomplishment.

Fundulus majalis I never succeeded in transferring, no doubt because of its being a purely marine species.

Cyprinodon variegatus also can be gradually accustomed to a change of water, but being practically only an anadromous fish during breeding time does not very long survive.

It is possible that these cyprinodonts being great rovers can ill bear small quarters and this may be one reason for their shortlivedness in captivity, as compared with the quieter cyprinids for instance.

Transfers were never successfully made to "hard," that is, well water. I never used distilled water but simply rain or city tap water.

Experiments made with Sticklebacks.—*Gasterosteus aculeatus* and *pungitius* and *Apeltes quadracus* also bear transfer which may ordinarily be made quite suddenly and without great loss. I transferred back an *aculeatus* directly from fresh to salt water; it survived only a few days, but as it was a spent male (in the fresh water) this may not be considered a fair test.

Suddenly transferred fishes drop to the bottom of the tank and slowly move about after some time; this is due to the difference in density chiefly, but differences in the temperatures of the water also have this effect, though it is sooner overcome.

EUGENE SMITH

HOBOKEN, N. J.

SCIENTIFIC BOOKS

The Flora of Boulder, Colorado and Vicinity.

By FRANCIS POTTER DANIELS. Volume II., No. 2, University of Missouri Studies. Price, \$1.50.

The author of this excellent piece of work is not a professional botanist but a specialist in Romance languages. While engaged in teaching French in the summer session of the University of Colorado in 1906 he made the collections upon which the present report is based. Through the University of Missouri, with which institution Dr. Daniels was formerly connected, his book of over 300 large octavo pages has been issued as a number of the "University of Missouri Studies." It is sumptuously printed in large type with wide margins and generous spacing.

Dr. Daniels collected 1,036 species of plants during the single summer that he was in Boulder. To this number are added in his printed list some species reported from the vicinity in Rydberg's "Flora of Colorado" together with others from various sources. The total number listed seems to be about 1,240. At various points in the body of the list new species and varieties are described. It is unfortunate that because of lack of time Dr.

Daniels was unable to consult the university herbarium at Boulder. This collection, containing some 5,000 sheets of Boulder County specimens, is, therefore, not reported upon in the present publication. However, the large number of plants collected by the author himself must surely comprise a very considerable part of the flora. His list is bound to be of great use to students of the local flora.

In addition to the systematic list of species and localities there is a fifty-page introduction in which various ecological matters are discussed. This is evidently not written for the professional botanist for the language is popular, not to say "breezy." One is therefore just a bit surprised by such terms as *Ensiformes*, *Rimosæ*, etc., which, set in heavy bold-face type, stare uncompromisingly at the patient reader who may happen to be innocent of a knowledge of the classical languages.

A very full index completes this creditable publication.

FRANCIS RAMALEY

UNIVERSITY OF COLORADO,
BOULDER, COLO.

SCIENTIFIC JOURNALS AND ARTICLES

Terrestrial Magnetism and Atmospheric Electricity for September, 1911, contains the following articles:

"Magnetic Chart Errors and Secular Changes in the Indian Ocean," by L. A. Bauer and W. J. Peters.

"Comparisons of Magnetic Observatory Standards by the Carnegie Institution of Washington, No. II.," by J. A. Fleming.

"Data for Abruptly-beginning Magnetic Disturbances, 1906-1909, No. II.": Reports from Batavia-Buitenzorg; Zi-ka-wei and Lu-kia-pang; Kew; Mauritius; Eskdalemuir; Dehra Dun, Kodaikanal, Barrackpore and Toungoo; Tortosa; Samoa; Falmouth; De Bilt; Rud Skov; Pilar; and additional data for Potsdam; Agincourt; Porto Rico, Cheltenham, Baldwin, Sitka and Honolulu.

"Peculiar Magnetic Disturbances of December 28-31, 1908," by R. L. Faris.

"The Magnetic Character of the Year 1910," by G. van Dijk.

"Mean Values of the Magnetic Elements at Observatories," compiled by J. A. Fleming.

Articles in the December issue are:

"On the Magnetic Field of the Earth," by L. Steiner.

"The Physical Theory of the Earth's Magnetic and Electric Phenomena, No. IV.," by L. A. Bauer.

"Atmospheric Electricity Observations on the Second Cruise of the *Carnegie* from New York to Colombo," by E. Kidson.

"On the Normal Magnetic Elements at the Mauritius Magnetic Observatory," by L. A. Bauer.

**TREMATODE GENERIC NAMES PROPOSED
FOR THE "OFFICIAL LIST OF
ZOOLOGICAL NAMES"**

1. The International Commission on Medical Zoology, appointed by the Graz International Zoological Congress, has made its first report on the names of Trematode genera parasitic in man.

2. Four members, namely, Blanchard (Paris), Monticelli (Naples), Stiles (Washington) and Zschokke (Basel), unanimously agree that the following eleven names are from the present standpoint of systematic zoology and nomenclature, the correct names for the genera in question, and that the species cited as genotypes are the correct types according to the International Rules of Zoological Nomenclature.

Clonorchis Looss, 1907, Feb. 1, 147-152, type *sinensis*.

Dicrocoelium Dujardin, 1845a, 391, type *lanceatum* = *lanceolatum* (= ? *dendriticum* sub judice).

Fasciola Linnæus, 1758a, 644, 648-649, type *hepatica*.

Fasciolopsis Looss, 1899b, 557, 561, type *bushkii* (seu *buskii* teste Blanchard).

Gastrodiscus Leuckart in Cobbold, 1877e, 233-239, type *sonsinoi* (seu *sonsinoi* teste Blanchard).

Heterophyes Cobbold, 1866a, 6, type *egyptiaca* = *heterophyes*.

Metorchis Looss, 1899b, 564-566, type *albidus*.

Opisthorchis Blanchard, 1895f, 217, type *felinus*. *Paragonimus* Braun, 1899g, 492, type *westermanii* (seu *westermanni* teste Blanchard).

Pseudamphistomum Luehe, 1908, 428-436, type *truncatum*.

Watsonius Stiles & Goldberger, 1910, 212, type *watsoni*.

3. The following commissioners have not voted: Jaegerskiöld (Gothenburg), Looss (Cairo), Luehe (Koenigsberg), Pintner (Vienna) and Shipley (Cambridge).

4. Notice is hereby given that the undersigned will wait until July 1, 1912, for any zoologist to raise objection to any portion of this report, and that on that date all names to which valid objection is not raised will be forwarded to the International Commission on Zoological Nomenclature with the motion that these names be included in the "Official List of Zoological Names" provided for by the Graz Zoological Congress.

5. All correspondence on this subject should be addressed to

C. W. STILES,

*Secretary International Commission
on Zoological Nomenclature*

HYGIENIC LABORATORY,

WASHINGTON, D. C.,

November 11, 1911

SPECIAL ARTICLES

NOTES UPON *CRONARTIUM RIBICOLA*¹

A NUMBER of new points have been worked out in connection with this fungus during the past year. A coarse yellow mottling of pine needles and of the bark on the twigs and leader occurs rarely, but is very characteristic when it does occur. It seems to occur only in trees which have had the disease for more than one year. It has developed in the greenhouse upon plants which were known to be infected and has been found in one lot of trees set out in the field.

In 1910 an attempt was made by the speaker to pick out all the infected trees in a lot of 10,000 three-year-old white pines. The remainder were then planted out by state authorities in a large open field where every tree could be easily found the next year, and in a locality where *Ribes* were absent for a considerable distance. An examination the next summer showed a considerable number which had swellings of the bark, but none were found with fruiting bodies of the *Perider-*

¹ Presented before the American Phytopathological Society, December, 1911.

mium. This, together with other experience along similar lines, convinced the speaker that the best single inspection possible will not remove all infected trees from a diseased lot. There will be at least a few hold-over cases which will develop afterward. This makes repeated inspection absolutely necessary and such repeated inspections *very* soon cost more than the value of the entire lot of trees. In most cases it will be real economy to pull up the trees and burn them at once.

The speaker, in cooperation with the state authorities, discovered the disease for the first time in the states of New Jersey and Virginia in 1911. In the former case the entire lot was destroyed by the owner, while the action taken in the latter is not known. No fruiting bodies were found in Virginia, but the swollen stems were present in a few cases. During the past year the disease has been shipped to us by a French firm and inquiry showed that they raised their trees themselves.

The finding of the teleuto stage of the fungus affecting the stipule and bracts of a *Ribes* leaf in the greenhouse, is believed to practically prove that the fungus may sometimes attack the bud scales of dormant bushes and cuttings; this very probably explains the anomalous appearance of this fungus in this country upon *Ribes* at Geneva, N. Y., and possibly in Kansas.

The single German nursery of J. Heins's Sons has sent us over 95 per cent. of the total amount of diseased stock that has been found in this country, yet they say they have no disease in their nursery. Barely a month ago the writer received samples of their white pine stock, which had just been submitted to the superintendent of the New York State Forests by Heins's Sons, and one at least had visible swelling of the stem, which the writer is confident is caused by the blister rust. This shows that he was correct in his former suspicion that they do not know the field characters of this disease. Inoculations have been successfully made by the writer with spores from diseased white pine trees sent by J. Heins's Sons to Lake Clear Junction and Salamanca, New York, and to the states of New Jersey and Connecticut, upon *Ribes* in

the greenhouse. The shipments thus tested were made in 1908, 1909 and 1910.

Experience with greenhouse inoculations on *Ribes* shows that the teleuto stage develops only after the cool weather of autumn sets in: that is, the uredo stage flourishes through the summer, but the teleuto stage does not appear until cooler weather prevails. The experiments for two years agree in showing this peculiarity. Greenhouse inoculations have been made upon young *Pinus strobus* with teleutospores secured by inoculation on *Ribes americanum* with æcidiospores borne upon imported trees of *Pinus strobus*. Inoculations thus made in November, 1910, are now beginning to give results. One each of the trees inoculated with wounds and without wounds is now showing slight swelling such as is so characteristic of the blister rust disease.

PERLEY SPAULDING

OFFICE OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

THE BOTANICAL SOCIETY OF AMERICA

THE annual meeting of the Botanical Society of America was held at the Business High School, Washington, D. C., December 27 to 29, 1911.

The following were elected officers for the ensuing years:

President—L. R. Jones, University of Wisconsin.

Vice-president—B. M. Duggar, Cornell University.

Secretary—G. T. Moore, Washington University.

Councilor—Wm. Trelease, Missouri Botanical Garden.

These, with Arthur Hollick, treasurer, and C. L. Shear and R. A. Harper, councilors, constitute the council for 1912.

The following associate members were elected to full membership: D. H. Campbell, Stanford University; M. L. Fernald, Harvard University; J. B. Overton, University of Wisconsin; P. H. Rolfs, Florida Experiment Station; P. A. Rydberg, New York Botanical Garden.

Botanists elected to associate membership were: I. W. Bailey, Harvard University; F. S. Collins, Malden, Mass.; C. W. Edgerton, Louisiana Experiment Station; J. H. Faul, University of Toronto; R. McM. Harper, University of Alabama; H. Hasselbring, Bureau of Plant Industry; C. E.

Lewis, Maine Experiment Station; F. Ramaley, University of Colorado; D. Reddick, Cornell University; Frances G. Smith, Smith College; A. Stewart, University of Wisconsin; H. N. Whitford, Bureau of Forestry, Manila; F. D. Wolf, Alabama Experiment Station.

The address of retiring President Erwin F. Smith on "Some Aspects of the Relationship of the Crown-gall Disease to Human Cancer" and the symposium on "Modern Aspects of Paleobotany," participated in by F. H. Knowlton, John M. Coulter, Edward C. Jeffrey and Arthur Hollick, will be published and distributed to the members of the society.

The dinner for all botanists was held Thursday night. Mr. David Fairchild was toastmaster and a number of botanists spoke briefly upon the particular aspect of work in which they were interested.

The smoker given by the members of the Washington Botanical Society to all visiting botanists, on Friday night, was largely attended and a most enjoyable affair.

Following are abstracts of papers presented at the symposium on "Modern Aspects of Paleobotany":

I. *The Relations of Paleobotany to Geology*: F. H. KNOWLTON.

The present paper emphasizes the fact that paleobotany, in common with all the other branches of paleontology, admits of subdivision into two lines or fields of study—the biological and the geological—depending upon the prominence given to the one or the other of these phases of the subject. As the biological side is to be handled by other contributors to this discussion, the present contribution is, naturally, confined to the geological aspects of the science. It is shown that fossil plants afford a series of stratigraphic marks, serving for the identification of geological horizons, that are unsurpassed in value by those afforded by any of the many other branches of paleontology; and nowhere in the world is this fact so thoroughly recognized and accepted as in North America. Objection is frequently made, especially by botanists, that impressions of plants, the form in which they are most utilized by geologists, are often of doubtful biologic value. In reply to this it is shown that while the paleobotanist uses his utmost endeavor correctly to fix the biologic status of the material he uses, it makes not the slightest difference to the stratigraphic geologist whether the fossils upon which he most

relies are correctly named, biologically, so long as their horizon is known and they are clearly defined and capable of recognition under any and all conditions. The various phases of this aspect of paleobotany are set forth in detail, especially in its general geological and economic applications. The value of paleobotany in the interpretation of geological climate is also treated at some length.

II. *The Relations of Paleobotany to Botany*.

1. *Phylogeny and Taxonomy*: JOHN M. COULTER.

It is impossible to disentangle morphology and phylogeny, for the largest motive in modern morphology is to construct phylogenies. An excessive amount of overlapping will be avoided in this paper by laying the emphasis upon the inferences to be drawn from morphological investigations as to probable lines of descent, rather than upon the morphological results themselves.

As a result of the recently developed paleobotanical connections, the phylogeny of the vascular groups can be made now a resultant of comparative structures and actual history. Many an old phylogeny, based upon the comparative structures of existing plants alone, has been contradicted by history, which, in the nature of things, must furnish the final check upon any proposed phylogeny.

The title of this paper includes the taxonomy, but in so far as this deals with great groups, defined or discovered, it is covered by the statements concerning phylogeny. So far as it deals with the recognition of individual forms, it is clear that paleobotany must learn to recognize the relationships of fossil plants, or there will be no reliable taxonomy or phylogeny. So long as paleobotany depended upon the form resemblances of detached organs, there could be no taxonomy in the real sense. It was merely a cataloguing of plant material. But when it learned to uncover structure, it began to establish a real taxonomy. The contributions of paleobotany to taxonomy, therefore, may be summed up in the statement that it has begun to extend our schemes of classification into the ancient floras; that this has resulted in a far truer view of the great groups than their expression in the present flora can possibly give; and that this makes a rational phylogeny possible.

Illustrations are given of the great changes of view, brought about by paleobotany, that have occurred during the last decade. The illustrations are taken from the Lycopodiales (*Lycopodium*, *Selaginella*, *Isoetes*), showing the present opinion

as to the relation between the paleozoic and the present representatives; from Equisetales, showing the recent development of knowledge in reference to the paleozoic forms; from Filicales, showing the disappearance of the paleozoic assemblage once called ferns, and the development of knowledge in reference to Palaeo-Marattiaceae and Priniofilices; and especially from Gymnosperms, showing the remarkable reconstruction of the phylogeny of that group.

The great problem of paleobotany to-day is the history of angiosperms. Having perfected a weapon in the attack upon gymnosperms, it remains for the paleobotanist who is a vascular anatomist to uncover the origin of our greatest group, with its comparatively brief history. The origin is probably recorded in the Mesozoic, and we wish to see the significant structures, and not guess at external form, and much less guess at purely hypothetical connections. To this great task paleobotany is turning. We have had the guesses; and I am confident that presently we will have the facts.

2. Morphology: EDWARD C. JEFFREY.

The often perfect condition of preservation of plant fossils and the comparatively unbroken series, which they present, from the remotest times to the present, has been of the greatest importance for the modern development of plant morphology. It is now clearly recognized that the doctrine of recapitulation, far from being solely exemplified by zoologic types, is much more clearly and certainly deducible from the historical and developmental study of plants, which in this as in so many other respects, show themselves more advantageous for evolutionary studies than animals. It is clear likewise from the studies of the past decade, or decade and a half, that external morphology, even that of the reproductive organs, is of comparatively slight importance in connection with the doctrine of descent or its practical application to the natural system. Applied to the internal structures, the doctrine of recapitulation has many and striking illustrations in plants living and extinct. The correlation of paleobotany with internal morphology has shown, moreover, that the investigation of reversions is a very profitable direction of scientific exploitation. In addition to exemplifying recapitulation and reversion, plants further present another law, which is for the most part not apparent in animals. It has been shown, namely, that of the separate organs of the plant, the stem is most progressive and that root and leaf

lag behind in evolutionary development. As a consequence it is often possible to discover the structures of a remote geologic past in the roots or leaves of plants now living. In the principles of the recapitulation, reversion and retention of ancestral characters, we have as it were the three fundamental R's of morphological science, by the aid of which we are now for the first time in the position to begin the construction of a natural system.

3. Ecology: ARTHUR HOLLICK.

Plant ecology is that branch of botany which comprises the study of the interrelations of plants and their relations to environment. As a distinct science it is practically a product of the present generation, and the term has only been recognized in common usage within the past twenty-five years or so.

The relation of paleobotany to botany, in connection with ecology, is mostly concerned with the problems of phytogeography. Paleobotany has supplied the explanations of many puzzling facts in regard to endemic floras; the occurrence of some genus or species only in certain widely separated regions of the earth, and the geographic isolation or limitation of others. Most of the phenomena of plant distribution in general at the present time would have no logical or adequate explanation but for the facts which have been revealed by the study of fossil plants and their distribution in the past.

Among the many striking instances in such connection may be mentioned the explanations which paleobotany has given in regard to the endemic floras of Australia and other regions; the distribution of such genera as *Nelumbo* and *Liriodendron*; and the geographic isolation of *Sequoia*, *Taxodium*, *Ginkgo* and other genera.

In tracing the facts of the ancestry, former distribution and extinction of species and genera paleobotany has demonstrated that there is no necessity for invoking the aid of inadequate and unsatisfactory theories of migration in recent times, or the origin of a genus, *de novo*, in two widely separated regions, in order to account for some of the puzzling phenomena of modern phytogeography.

Following are abstracts of the papers presented at the scientific sessions:

The Connective between Conidia of Penicillium:
CHARLES THOM, U. S. Department of Agriculture.

References to a "connective" (Brücke, Dis-

junktor, Zwischen-zelle) between the conidia in species of *Penicillium* are widely scattered through the literature. This was figured by Strasburger in "Zellbildung und Zelltheilung" (1879) and reappears in the latest discussion of the group by Westling (1911). The appearances described under these names are easily seen and commonly but by no means uniformly found in certain species. To discuss this the usual method of conidial formation must be briefly described. The spore-bearing cell (sterigma, basidium, conidiiferous cell) has a definite permanent length of fairly uniform diameter, then tapers into a tube of smaller diameter from which the conidia are abstracted. This fertile tube elongates rapidly during the growing period. The nucleus of the cell divides, one daughter nucleus migrates to the tip of the tube, a wall then cuts the new cell from the old. The newly formed conidium in every species so far carefully studied is cylindrical, and more or less quickly swells to assume the globose or elliptical form characteristic of the particular species. The cylindrical form is lost so quickly that many preparations will not show such conidia, especially where growth conditions are not especially favorable. Similarly the tube may be very short or 2 to 3 μ in length in the same preparation. As the conidia swell from the cylindrical to the elliptical or globose form the appearance described as a connective is obtained when the primary wall of the original tube fails to follow the change in form and leaves an open space between itself and the new walls of the adjacent conidia in the chain. This appearance is by no means uniform in any species examined, but admits of the same explanation in every case seen. Nuclei have been fixed and stained in but few of these forms.

Perennial Gametophytic and Sporophytic Generations in Puccinia obtogens (Lk.) Tul.: EDGAR W. OLIVE, South Dakota State College of Agriculture and Mechanic Arts.

This brachyform of rust, better known under the name of *P. suaveolens*, grows at Brookings on an European variety of Canada thistle. As described by Rostrop and others, it is said to possess two distinct generations: one resulting from a general infection throughout the whole plant, in which the characteristic, sweet-smelling pycnidia are shortly followed by large, confluent sori of uredospores, among which are later developed a few teleutospores; and, second, a strictly local infection, in which only uredo- and teleutospores are produced and borne in small, scattered sori.

Some preliminary cytological investigations of the so-called first generation show that both uninucleated gametophytic and binucleated sporophytic mycelia ramify together throughout the infected plants. The uninucleated mycelium produces the pycnidia; and is present also at the base of the uredo-sori. But the binucleated mycelium also invades the uredo-sori and these sporophytic hyphae alone apparently produce the uredospores, which therefore should be regarded as secondary in their nature. Primary uredospores, produced by sexual fusions, were not observed. Teleutospores also arose from the same sporophytic mycelium.

The general infection of the Canada thistle is therefore due to the growth of two generations: a mixture of gametophytic as well as sporophytic mycelia; and the evidence appears to show further that both uninucleated and binucleated mycelia winter-over together in this mingled state in the underground parts of the plant.

A Revision of the North American Species of Puccinia on Carex: FRANK D. KERN and MARY A. FITCH, Purdue University.

Although there has been an accumulation of considerable information concerning the North American sedge rusts most mycologists have regarded this group as especially difficult. This is perhaps due to the fact that the telia do not usually present diagnostic characters. In the separation of these species it has been necessary to look for other features, and, as has been the case in several other groups of the rusts, it has been found that the urediniospores have furnished especially good characters. The aërial connections as brought to light by cultures are also important. The presence of amphispores in some of these species and the splitting of other species into races lend biological interest to these studies. About twenty-five species of *Puccinia* on *Carex* can be recognized in North America, the majority being endemic. About three fifths of these have had their life-histories worked out.

Cultures of Uredineæ in 1911: J. C. ARTHUR, Purdue University.

The thirteenth year of culture work with plant rusts gave an unusual number of failures, largely ascribable to the unseasonable hot weather. Of the 193 available collections with resting spores, mostly on grasses and sedges, only 37 germinated, as proved by about 700 drop-culture tests. Out of the small number 14 infections were obtained, with 143 sowings. In addition to these 17 infections

were obtained from freshly gathered material of *Gymnosporangium*, *Peridermium* and *Æcidium*, out of 91 sowings.

The most important results of the year were (1) finding an æcial host for *Gymnosporangium speciosum* outside of the families Malacææ and Rosacææ, i. e., on *Philadelphus*, belonging to the family Hydrangiaceæ, and (2) finding that both the *Uromyces* and *Puccinia* on *Distichlis spicata* produce indistinguishable æcia on the same æcial hosts. The latter result taken in connection with facts brought out in former culture work leads to the conclusion that in some cases at least forms placed in the two genera, *Uromyces* and *Puccinia*, are not worthy of generic difference, and scarcely entitled to specific difference. They more truly represent races, or possibly varieties, of one species, rather than two species belonging to two genera.

Plus and Minus Strains in an Ascomycete: C. W. EDGERTON, Louisiana Experiment Station.

A species of *Glomerella* collected on a petiole of a cottonwood leaf in Louisiana has been producing perithecia on culture media for nearly a year and a half. The original culture has been separated into two distinct strains, called Plus and Minus. The Plus strain develops mature perithecia in masses occasionally, these being identical with other species of *Glomerella*. The Minus strain develops the perithecia singly or in two's or three's over and in the medium, but these do not come to maturity except on certain media and then the asci are very ill-shaped. When the two strains are grown on the same plate, there is a boundary line, where they come in contact, of well-developed perithecia. There is a cross-fertilization between the two strains, as is shown by the fact that ascospores in the same perithecium develop both strains on culturing.

The Morphology of Zygorhynchus and its Relation to the Ascomycetes: GEO. F. ATKINSON, Cornell University.

In *Zygorhynchus* the fruiting hyphæ are aerial and arise from the submersed vegetative mycelium. The branching is sympodial, the first sporangium terminating the primary hypha, the system finally bearing several sporangia, the successive ones usually standing higher. The sporangial branches are often more or less spirally curved.

The branched gametophore is the morphological equivalent of the sporangiophore, and the sexual branches are morphologically equivalent to the sporangial branches, and arise according to the

same plan. The gametophores and sporangiophores are usually pure, but sometimes mixed.

The first antheridial branch is terminal, and subtended by the oogonial branch. The latter curves around, is often spirally twisted, and comes in contact with the former, usually touching it on the side. The end of the oogonial branch then enlarges into an oval body and is divided by two cross walls. The terminal pointed cell in contact with the antheridium is the homologue of the ascomycete trichogyne, and the subterminal cell is the egg. The "zygospore" wall eventually includes the two cells.

The sexual apparatus of *Zygorhynchus* is of the same type, and may be regarded as representing the ancestral form of the same, in *Monascus*, *Gymnoascus*, *Pyronema*, etc., and the gametophore may be regarded as representing the ancestral form of the Laboulbeniales. It does not seem necessary, therefore, to derive the ascomycete trichogyne from the Rhodophycææ.

Development and Fertilization in Olpidiopsis: J. F. BARRETT, University of Illinois.

Three species of *Olpidiopsis* were included in this study: *O. Saprolegnia* Cornu, on *Saprolegnia*; *O. vezans* nov. sp., on *Saprolegnia*, and *O. luxurians* nov. sp., on *Aphanomyces*.

Zoospores biciliate with the cilia of equal length and attached at or near the anterior end of the elongated body. Zoospores possess two motile stages separated by a brief period of rest, suggesting a primitive type of diplanetism. Individuality of the zoospore, after penetrating the host, is maintained throughout its development. Little if any amœboid movement.

Segmentation of the sporangial contents apparently simultaneous throughout. Zoospores on escaping contain vacuoles.

True sexuality probably exists, and takes place by the fusion of two sexually differentiated individuals and the subsequent passage of the protoplasm of the smaller, male, into the larger, female, cell. This is followed by a supposed fusion of nuclei.

Both sexual and asexual reproductive bodies develop rather rapidly from a uninucleate to a multinucleate condition. The oospore is likewise multinucleate.

External conditions play a great part in the determination of sex in these organisms. This fact adds evidence, it seems, to the doctrine that sex in many plants is determinable by external or nutritive conditions.

Nuclear division is mitotic with the nuclear spindle intranuclear.

Variations in Glomerella: C. L. SHEAR, U. S.

Department of Agriculture.

The results are given of studies of various races, strains, varieties and species from forty-six different host plants. Variations in morphological characters of all kinds were observed. Great variations in physiological characters, such as virility, adaptability to various hosts and reaction to culture media, also occurred.

Numerous generations started from single ascospores and conidia were grown under the same conditions. Rather striking and sudden variations occurred in some of these cultures, also intergrading forms and variations appeared. The conidial generations showed greater variation than the ascospore generation. Most of the variations studied show no direct relation to the culture media or other conditions of environment. More or less distinct races or strains were found to occur on the same host. These strains maintained their principal characteristics in cultures as long as they were grown.

The Perfect Stage of the Rose Actinonema: F. A. WOLF, Alabama Experiment Station.

The fruit bodies of *Actinonema roseæ* are not pycnidia as in the Sphaeropsidales, but acervuli as in the Melanconiales. Persoon, who described the genus *Actinonema* ("Mycol. Eur.," 1822) characterized it as having radiate, sterile, mycelial strands. Fries ("Summa veg. Scand.," 1849), whose characterizations Saccardo employs, describes the genus as having a fibrillose radiating mycelium, a delicate perithecium and bilocular spores. The genus *Marsonia*, whose conidia are similar to *Actinonema*, has a subepidermal acervulus. The acervulus of *Actinonema roseæ* is subcuticular. The rose fungus evidently possesses the characters of neither a typical *Marsonia* nor of an *Actinonema*.

Leaves affected with the conidial stage, when wintered out-of-doors, developed a microthyriaceous ascospore stage. The shield and spores are like *Asterella*. These perithecia though consist of a subcuticular shield and an innate apothecium which are entirely separate in origin and open like the Phæcidiales. The Microthyriaceæ are superficial and with a well-developed structure only on the upper side. The type of development as exhibited in the rose fungus is not like *Asterella*, which has been made to include heterogeneous elements and so a new generic name, *Diplocarpon*,

is proposed. This study connects for the first time the conidial and ascospore stages of the organism causing the black spot of roses. The new name *Diplocarpon roseæ* is given to the fungus.

Infection Experiments with the Powdery Mildew of Wheat: GEORGE M. REED, University of Missouri.

Experiments have been made in which eighty different varieties, belonging to nine different species of *Triticum*, were inoculated with conidia of *Erysiphe graminis* DC. occurring on wheat. By far the larger number of these varieties proved entirely susceptible to the fungus. Forty-eight varieties gave an infection of 100 per cent.; seventeen, an infection of 70 per cent. or higher; four, an infection of 50 to 70 per cent.; four, a low percentage of infection (4 to 27 per cent.); and seven proved practically immune to the mildew. In the case of some of the latter varieties an occasional partial infection was noted.

The seven immune varieties found belonged to two species (*Triticum dicoccum* and *Triticum vulgare*), five of these varieties belonging to the former and two to the latter species. The emmers, as a group, have proved to be quite free from infection, although some, as the Winter Emmer and Red Emmer, were entirely susceptible. It was noted that in every case the varieties which proved to be highly resistant to infection are spring varieties.

No one of the nine species of *Triticum* tested proved to be entirely immune. In every case one or more varieties belonging to each of the species gave infection.

The Organization of the Hymenium of the Hymenomycetes: A. H. REGINALD BULLER, University of Manitoba.

The Nature and Proper Treatment of Lichens: BRUCE FINK, Miami University.

An outline of the discussion to appear in the second paper of the series on "The Nature and Classification of Lichens" now being published in *Mycologia*. A statement of the difficulties due to the traditions regarding lichens and the consequent inconsistent treatment of lichens by many botanists. A brief outline of the arguments for or against various ideas and hypotheses, especially those of de Bary, Schwendener, Reinke, Schneider, Peirce, Danilov, Elenkin, Famintzin, Bessey and Clements. A conclusion reached as to whether the lichen is a colony, a dual organism or a fungus. In conclusion, the fundamental problems regarding the proper treatment of lichens by morphologists,

taxonomists, physiologists and ecologists are discussed briefly.

The Deposition of Iron on the Mycelium of an Aquatic Fungus: GEORGE T. MOORE, Washington University.

An aquatic ascomycete having peculiar spine-bearing spores, which readily germinate, was described. The mycelium from the germinating spores soon becomes encrusted with iron in much the same way that the so-called "iron bacteria" are covered with a deposit of iron. The material was particularly favorable for demonstrating that the process of iron deposition was not a vital one, as has been supposed for the bacteria.

A New Wood-penetrating Alga: GEORGE T. MOORE, Washington University.

An unbranched filamentous alga, with affinities with the Cladophoraceae was found penetrating the cells of a yellow pine board, which had been submerged in an aquarium for several years. The germination of the akinetes and peculiar habit of growth was described.

The Structure and Development of the Colony in Gonium: R. A. HARPER, Columbia University.

The 16-celled colonies of *Gonium* are formed from the mother-cell by definite mosaic development and are thus in sharp contrast with the colonies of *Hydrodictyon* or *Dictyostelium*. The mother-cell divides by three successive bi-partitions, the successive planes of division cutting each other at right angles. Each cell of the daughter colony occupies the same position in relation to its sister cells as it had in the undivided protoplasm of the mother-cell. The plane of the first division is apparently determined within the cell. The different cells of a mother colony divide at all angles with the plane of the colony as a whole. The changes of position and form which the cells of the daughter colonies undergo as they grow to mature size are apparently determined entirely by relations of adhesion, surface tension, etc. Only qualities of the cells as such appear to be transmitted; the organization of the colony as a whole is only indirectly represented in the mother-cell.

Some Physiological Conditions in the Mother-cell of Spirogyra: W. D. HORT, Rutgers College.

A large part of the trouble commonly experienced in growing algae in the laboratory is probably due to the water used, since, in physiologically pure water, *Spirogyra* was kept in perfect condition for several months. The nutrient solutions of Sachs, Molisch, Knop and Crone were tried. The best growth was obtained in Crone's

solution containing from 0.05 per cent. to 0.1 per cent. of total salts.

As has been shown by others, tap water and ordinary distilled water were highly toxic. The contained toxic substances were partially or wholly counteracted or removed by the addition of some, but not all, absorbing substances; by a high concentration of nutrient salts—0.5 per cent. to 1 per cent. of total salts; or by great heat. The results obtained indicate that the toxic bodies of tap water and distilled water were different substances; that those of tap water were, in part, volatile organic substances; and that those of distilled water were largely non-volatile inorganic substances.

A good growth was obtained only when a properly balanced solution containing all the nutrient salts was used, but the salts of any two of these metals gave a better growth than the salt of any one metal when used alone. No specific antagonistic action was observed—a mixture of magnesium and potassium salts seemed just as favorable as a mixture of magnesium and calcium salts.

A colloidal solution of silver was fatal in all concentrations as low as 0.0000045 per cent. and was injurious in concentrations as low as 0.000000225 per cent. The addition to the weaker silver solutions of a 0.05 per cent. concentration of Crone's solution or of animal carbon produced marked improvement in the solutions. A colloidal solution of gold was only slightly injurious at a concentration of 0.009 per cent., while a colloidal solution of platinum of a .0096 per cent. concentration was not only not injurious during a short time, but produced improvement in tap water, in a weak colloidal silver solution, and in a solution of magnesium sulphate.

When filaments of *Spirogyra* were placed in colloidal gold or platinum, to which was added about 0.015 per cent. NaOH, the outer layers of their walls swelled and formed gelatinous-looking sheaths which often broke off in crumpled masses. These sheaths were not formed in either the platinum solution alone or in the NaOH solution alone, but were formed when both NaOH and either gold or platinum were present. These sheaths were deeply colored by the gold and platinum, while the layers of the wall which formed no sheaths remained uncolored.

The Effect of Light on the Liberation of the Eggs and Spores of Dictyota dichotoma: W. D. HORT, Rutgers College.

As the eggs of *Dictyota dichotoma* approach maturity, two layers can be distinguished in the walls of the oogonia, of which the inner becomes very thick as the egg ripens. In the discharge of the egg, the outer wall is burst, while the inner, still enclosing the egg, is protruded and is soon dissolved, freeing the egg and allowing it to round up. The outer layer of the oogonium wall then appears as a ruptured, crumpled membrane.

The discharge of the tetraspores was not observed, but probably occurs by the same mechanism since the young, mature and empty walls of the tetraspore mother cells show the same appearances as those described for the eggs.

Both at Naples and at Beaufort, North Carolina, the discharge of eggs in the laboratory began very early in the morning, when daylight was just visible or even, at times, before the slightest trace of light was discernible. At Beaufort, the time when this discharge commenced varied in different summers, and in the latter part of any one summer, but was fairly constant for the earlier months of each summer. Both at Beaufort and at Naples, about 70-80 per cent. of the eggs liberated in any one day were discharged within the first half hour and about 80-90 per cent. were discharged within the first hour. At Beaufort about 70-80 per cent. of the entire crop of eggs were thus liberated within a single hour of one day of each month.

Attempts to alter the time of the discharge by subjecting the plant to various conditions of light and darkness were effective only as they affected the healthy condition of the plant. The attempt to induce liberation at other times of the day by exposure to various degrees of light, or to alternating darkness and light, was entirely without success. Discharge occurred as abundantly in dishes covered with red and with blue glass as in dishes covered with white glass.

The tetraspores were liberated throughout the day, although the majority were discharged before 7:00 A.M. Attempts to alter their rate of discharge by exposure to various conditions of light and darkness gave no marked result.

The experiments indicate that the light rays affect the liberation of eggs and spores by their effect on the well-being of the plants, rather than by acting as a direct stimulus to the discharge of these cells.

Alternation of Generations in certain Floridæ:
I. F. LEWIS, Randolph-Macon College.

Species of several genera of Floridæ have been cultivated during the past two summers at Woods Hole. By using the method employed by Hoyt with *Dictyota* it has been found possible to rear to maturity sporangia of known origin. In this way it has been shown that in *Griffithsia Borneatiana* and in *Dasya elegans* tetraspores without exception gave rise to sexual plants, which in *Dasya* were mostly male, and in *Griffithsia* about half male and half female. In *Polysiphonia violacea* carpospores produced, also without exception, tetrasporic plants. Hundreds of cases were observed. The experiments cited may be regarded as proof of the assumption, on cytological grounds, that there is an alternation of sexual and asexual individuals in Floridæ producing both tetraspores and carpospores.

The Germination of the Spore of Nematolium multifidum: I. F. LEWIS, Randolph-Macon College.

After being shed, and attaching themselves to some hard substratum, the spores of *Nematolium* remain without visible change save a slight increase in size for twelve to twenty-four hours. The center of the spore is occupied by the large chromatophore with its pyrenoid, the latter bearing a marked resemblance to a nucleus, but larger. The small nucleus lies to one side of the pyrenoid. The first sign of germination is the protrusion of a germ tube through the spore wall. Into this the pyrenoid passes, along with most of the protoplasm. The spore cavity is left nearly empty. The nucleus, lying at the base of the germ tube, divides in the manner described by Wolfe for the nuclei of vegetative cells. One of the resulting daughter nuclei passes into the germ tube, the other into the spore cavity, where it becomes closely appressed to the wall as a structureless mass. The number of chromosomes in the first and later divisions is probably 8. A cross wall separates the germ tube from the nearly empty spore body, the latter taking no further part in development and soon dissolving in the sea water. The germ tube continues to elongate, and its nucleus divides in the usual way. The pyrenoid divides at about the same time, and a second cross wall cuts the germ tube into two parts, each with nucleus, chromatophore and cytoplasm. The apical cell so formed grows in length and divides. Repetition of this process results in the formation of a monosiphonous filament.

Nuclear Division in Spirogyra setiformis: F. McALLISTER.

The first indication of nuclear division is the accumulation of protoplasm at the poles of the nucleus. Later the nucleole loses its regular outline and stainable material seems to be given off from it into the nuclear cavity. No spirem seems to be formed from the reticulum. When the nucleole is nearly or wholly disintegrated, fibers from the polar region enter the nucleus and at the same time all the stainable material contracts to form the equatorial plate. This now separates into two parts, which move to the poles as dense homogeneous masses. Vacuoles appear and ultimately the stainable material is uniformly distributed through the daughter nucleus as pale blue-staining bodies. Red-staining bodies appear. The blue-staining bodies lose their distinctness and part of them, at least, form a homogeneous blue-staining ground substance in which the several red, nucleole-like bodies are imbedded. This mass rounds up to form the nucleole of the resting nucleus. During nucleole formation a delicate reticulum has appeared.

The Effect of Gymnosporangium upon the Transpiration and Photosynthesis of Apple Leaves:
HOWARD S. REED and J. S. COOLEY, Virginia Agricultural Experiment Station.

In connection with pathological studies, the authors made determinations upon water elimination and carbon-dioxide consumption of healthy and rusted apple leaves. The varieties of apple known as York Imperial and Ben Davis were used. Transpiration was measured on twigs on the trees and determined in grams per square centimeter per hour. An average of five tests on Ben Davis apple leaves showed that in rusted leaves the water elimination was 50 per cent. of that in healthy leaves on the same trees.

For determining the rate of photosynthesis Ganong's photosynthometers were used. Experiments were always run in duplicate, using healthy and diseased leaves. Results were expressed as cubic centimeters of CO_2 consumed per square centimeter per hour. The diseased leaves showed marked diminution in power to consume CO_2 .

A Study of Protoplasmic Movements in Fungi:
F. M. ANDREWS, Indiana University.

Very little work has been done on the subject of protoplasmic movements in fungi. This study was undertaken in Pfeffer's laboratory to ascertain if the few observations made were correct and to extend them.

The fungi used for this investigation were *Mucor stolonifer*, *M. mucedo* and *Phycomyces*

nitens. They were grown in various nutrient media such as a 4 per cent. solution of cane sugar; in gelatine (generally 10 per cent.), plum juice and others.

In making these investigations it was first attempted to determine the nature of the protoplasmic movements in the fungal filaments as they occur under ordinary conditions. Secondly it was desired to ascertain the effect of external conditions in the streaming movements such as temperature, food, transpiration, osmosis, light, injury, etc.

The most favorable temperature for growth is from 23 degrees to 26 degrees for the plants used. Below the optimum sudden rise in temperature of a few degrees results in movement if the protoplasm is still or an acceleration where slow movement is already present if all the other conditions are perfect.

In most cases those nutrient media containing sugar of sufficient strength produced an active growth and filaments having a large diameter which was necessary for favorable study. The gelatine and plum juice media also produced actively growing and wide filaments. In some other media, as where the sugar was entirely absent, only feeble narrow filaments were found.

In actively streaming specimens dry air caused acceleration for a time and then cessation of movement. On using moist air immediately after movement recommenced.

Streaming can also be produced in the filaments of these plants by placing a solution of sugar about the filament. Streaming then begins and continues according to the strength of the solution for some time. If after stoppage of the movement fresh water is added, the movement recommences.

Light, while not so noticeable as the other factors mentioned, causes a slight acceleration of movement of the protoplasm after the plant has been darkened for a considerable time.

Also injury, if not too severe, may cause movements to begin. All the conditions here mentioned have no effect unless the protoplasm is in a condition for streaming.

A Method for Preparing Stained Cells in Toto for the Study of Karyokinesis: ALBERT MANN, U. S. Department of Agriculture.

A Comparison of the Somatic and the Reduction Divisions in Carex aquatilis: A. B. STOUT, New York Botanical Garden.

In *Carex aquatilis* the chromosomes can be identified as individuals in the resting nuclei in

root tips, tapetum and sporogenous tissue and they can be traced as separate individuals throughout the whole process of somatic cell division. They also maintain a serial order in which the chromosomes appear as individual spheroidal masses with a relative place relationship. This is most clearly in evidence during the prophase.

In the prophase of the reduction division, on the other hand, the chromosomes appear at synapsis as an extremely thin double thread which in the thick spirem stage again appears single. This is in marked contrast to the somatic prophase where the chromosomes maintain a separate individuality which can be traced. In the preparation for the reduction division the substance is spun out and the chromosomes are so closely connected end to end that they can not be identified as individual units. It would appear that in this condition the opportunity is given for mutual influence and exchange of substance between homologous pairs.

After the reduction division occurs the three nuclei which lie at the apex of the wedge-shaped spore mother cell divide, making six nuclei which then die and become flattened out against the wall. The wall of the spore mother cell functions as the wall of the microspore.

In the resting nuclei of the microspores the chromosomes appear again as separate individuals.

Precarious Tests for Chemotropism of Roots: F. C. NEWCOMBE, University of Michigan.

There is probably no part of a plant so sensitive to so many external stimuli as the tip of the root. The root-tip will give tropic responses to gravitation, in many plants to light, to moisture, heat, chemicals, in many species to pressure, to wounds.

The author has found still another response—that to a water-imbibed body in a water-saturated atmosphere. A piece of wet filter paper or of unglazed porcelain attached to the sloping side of the root will call forth a negative curve even in a water-saturated atmosphere. This result may be due either to a disturbance of hydrostatic conditions within the cells of the root, or to the accumulation in the attached body of volatile excretions of the root. The possible excretions must be volatile; for repeated use on successive roots of the same bits of paper, without washing, leads to no greater response. Either of the two possibilities assumed above could be interpreted as effecting traumatropic curves.

This extreme sensitiveness of the root-tip shows

how precarious are the results of authors who think to test the chemotropism of roots by applying to the tip bits of paper imbibed with chemicals.

The Nature of the Absorption and Tolerance of Plants in Bogs: ALFRED DACHNOWSKI, Ohio State University.

The considerations of the quantitative nature of habitat factors, which are rightfully desired as a basis for a theory of physiologically arid habitats, do not, however, render more clearly the nature of the absorption of plants in bogs and the nature of their tolerance to toxic substances in peat soils. The physico-chemical effects of toxic bodies are in part these: they reduce the available water content, and they act in varying degree directly upon the roots of plants and their functions. Since there are (under field and laboratory conditions) no differences in the evaporating power of the air, in temperature, in greater intensity of light, in the gradient of osmotic concentrations and in the possible rate of movement of water through the soil; and since no morphological limitations in the absorption and in the conduction of water (in the agricultural plants used) enter into the problem, the phenomena of absorption and of resistance to desiccation deal, plainly, with considerations of the permeability of the absorbing protoplasmic membrane, its power of endurance and its ability to transform the injurious bodies into insoluble, impermeable compounds. A study of the behavior of different species of cultivated plants and especially a number of their varieties forces the assumption that changes of a cytoplasmic nature are particularly important under the conditions of growth.

The Permeability of Protoplasm to Ions and the Theory of Antagonism: W. J. V. OSTERHOUT, Harvard University.

Experiments were performed to test the electrical conductivity of living tissues in various solutions. The results show conclusively that a great variety of ions readily penetrate living cells and that antagonism between salts may be explained by the fact that they hinder or prevent each other from entering the protoplasm. The ions of NaCl readily penetrate the protoplasm, but the addition of a small quantity of CaCl_2 greatly hinders this penetration. Such salts as KCl, MgCl_2 , CsCl, RbCl, LiCl, NH_4Cl , NaBr, NaI, NaNO_3 , Na_2SO_4 and Na-acetate act in general like NaCl while BaCl_2 and SrCl_2 act like CaCl_2 .

The mechanism of this action is not fully under-

stood, but it may be stated that CaCl_2 , BaCl_2 and SrCl_2 bring about visible changes in the plasma membrane which are quite different from those produced by such salts as NaCl , and it is hoped that a further study of these visible changes may throw some light on this question.

Observations on Evaporation and Transpiration in Prairie and Forest: B. SHIMEK, Iowa State University.

In an effort to determine the differences between forest and prairie plants which would account for their distribution, observations were made on the transpiration of certain forest and prairie plants in their native habitats and in transposed habitats. To illustrate the plan and purpose of the work two sets of plants are taken. In one of these cases *Phryma leptostachya* L. from the forest and *Kuhnia eupatorioides* var. *corymbulosa* T. & G. from the prairie were compared, and in the other *Anemone virginiana* L. from the forest and *Verbena stricta* Vent. from the prairie were employed for the same purpose.

Two stations were selected on a ridge near Iowa City, one side of which is prairie and the other forest, one station being located in each. The plants, which were as nearly as possible equal in size and vigor, were cut and inserted into bottles of water, which were sealed. Two plants, one from the forest and one from the prairie, were placed at each station, and the loss of water was determined at two-hour intervals.

In addition to this, observations were made at each of the stations on evaporation, and the meteorological conditions affecting it. The latter observations showed substantially the same relative results for prairie and forest as those previously published by the writer.

The results may be briefly summarized as follows:

The *Phryma* in the forest lost 1.9 gram, while that on the prairie lost 4.65 grams. The latter transpired very actively until it began to wilt, and then transpiration declined very rapidly, the plant soon becoming dry and crisp. The *Phryma* in the woods scarcely showed signs of wilting.

The *Kuhnia* in the forest lost 7.16 grams and remained perfectly fresh. That on the prairie lost 11.13 grams, and was also fresh at the close of the experiment. The diminution in transpiration in the forest was probably due in part to diminished activity on account of less intense light.

The *Anemone* lost 3 grams in the woods and 4.89 grams on the prairie.

The *Verbena* lost 6.58 grams in the woods and 27.4 grams on the prairie, transpiration in the woods declining in mid-day, being greater at both extremes of the day. The decline on the prairie in both cases was uniformly quite rapid. The greatest transpiration occurred in all cases just before wilting began.

The general result shows that transpiration and evaporation are not coincident.

Shade as a Factor Influencing Evaporation: G. P. BURNS, University of Vermont.

There is a general belief among some ecologists that the evaporating power of the air is the most satisfactory summation of the atmospheric factors controlling plant distribution.

In forest nurseries it is the usual practise to grow young pine trees in beds covered with racks whose sides are either wood or heavy paper and whose top is covered with lath. Every other lath is nailed, the free lath being later removed to produce "half-shade."

During the summer a study of the condition in the seed-beds has been carried on. The results as shown by the Livingston atmometer are given below.

Numerous stations were established representing all of the conditions found in nursery practise and in the adjacent forest areas. The control station was located in the nursery in a very large wire cage. The average amounts of daily evaporation from the various stations were as follows: control 45 c.c.; full-shade 19 c.c.; half-shade with solid sides 20 c.c.; half-shade with wire sides 43 c.c.; pine woods 16 c.c. Of these amounts from 17 per cent. to 25 per cent. is lost during the twelve hours 6 P.M.-6 A.M., the remainder during the time between 6 A.M. and 6 P.M.

The data gathered seem to show that the shading of young trees is a matter of evaporation rather than a matter of light, as is generally stated in the literature. The final word, however, must be spoken as a result of experiment.

The Investigation of a Climatic Gradient: FOREST SHREVE, Carnegie Institution.

The Santa Catalina mountains, in southern Arizona, rise from the desert plain at 3,000 feet altitude to a height of 9,100 feet. The lower slopes are characterized by desert vegetation, the middle altitudes by chaparral, the higher by coniferous forest. The influence of slope-exposure is such as to make the vertical limits of these zones and their component plants about 1,000 feet higher on

south-facing than on north-facing slopes. Instrumentation has been carried on at six stations, separated by vertical intervals of 1,000 feet. The data have furnished curves showing the altitudinal change of temperature, rainfall, soil moisture, humidity, evaporation and soil temperature. Mensuration has been carried on to determine the density and volume of the stands of characteristic trees at the different altitudes. Ratios of soil moisture to evaporation have been worked out from the instrumental data, showing the conditions which control the water intake and water loss of plants to be nine times as severe at 3,000 feet as at 8,000. The duration of the most critical season, as respects the water relation, is three times as long at 3,000 feet as at 8,000, making the desert conditions actually twenty-seven times as severe as those of the forested summits. The factors of soil moisture supply and atmospheric aridity, modified by slope-exposure, determine the lower limits of forest and the trees of the chaparral zone. The factors of winter cold, modified by topography through the operation of cold-air drainage, determine the upper limits of the characteristic desert species.

A Possible Mutant of the Sugar Maple: A. F. BLAKESLEE, Connecticut Agricultural College.

A single tree discovered in a roadside row of sugar maples is distinguished from the normal type by its peculiar habit of growth. The limbs are slender and branch profusely to form a close thicket of slender branchlets which end at a uniform distance from the trunk and produce an appearance similar to that of a symmetrical arbor vitae.

A Balancing Method for Differentiating between Absorption and Transpiration: LYMAN J. BRIGGS and H. L. SHANTZ, U. S. Department of Agriculture.

In this method the potted plant is suspended upon knife-edges in a horizontal position, so that the soil part of the system is on one side of the knife-edge and the plant on the other. The system is balanced by counter-weights, and a center of gravity so adjusted as to secure the required sensibility. As water is lost through transpiration, the soil end of the system becomes lighter and rises in consequence. If the moisture content of the plant has not changed during this process, the system will be restored to its zero position by the addition to the soil centroid of a weight equal to the total loss of water from the plant during the observation period. If the weight which must

be added to the soil centroid to balance the system is less than the total loss of weight during the period, then the amount absorbed by the plant has been less than the amount transpired. If the weight required to restore the balance is greater than the loss in weight of the system, then the absorption during the period has exceeded the transpiration.

If the distances of the soil and plant centroids from the axis are known, the difference between transpiration and absorption during any period can be quantitatively determined. The location of the soil centroid can be found by observing the loss of weight, after the plant has been kept for a time under uniform conditions, so that the transpiration is equal to the absorption for the observed period. The plant centroid is determined from measurements of the area and the distance of the leaves from the axis.

This method is also adapted to the determination of the wilting coefficient for plants, which, owing to structural peculiarities, do not wilt when the moisture content of the leaves is reduced.

The Application of Wilting Coefficient Determinations to Field Work in Ecology and Phytogeography: LYMAN J. BRIGGS and H. L. SHANTZ, U. S. Department of Agriculture.

The wilting coefficient is defined as the moisture content of the soil (expressed as a percentage of the dry weight) at the time when the leaves of the plant growing in that soil first undergo a permanent reduction in the moisture content as the result of a deficiency in the soil moisture supply.

The results of 1,300 determinations have shown that species differ only slightly in their wilting coefficients when grown in the same soil. The type of soil has a great influence upon the wilting coefficient, which ranges from less than 1 per cent. in sand to over 30 per cent. in the heaviest type of clay. It is therefore evident that soil moisture determinations for the purpose of establishing available moisture in the soil are valueless unless the wilting coefficient of the same sample used in the moisture determination is also known.

The desirability of a rapid determination of the wilting coefficient of samples taken in connection with field work led to an investigation to determine whether it could be computed from physical measurements of the moisture retentivity of the soil. Several methods have been developed, the relationships established being expressed in the following equations:

$$\text{Wilting coefficient} = \frac{\text{Moisture equivalent}}{1.34 (1 \pm 0.007)}$$

$$\text{Wilting coefficient} = \frac{\text{Hygroscopic coefficient}}{0.68 (1 \pm 0.018)}$$

$$\text{Wilting coefficient} = \frac{\text{Moisture-holding capacity} - 21}{2.90 (1 \pm 0.021)}$$

$$\text{Wilting coefficient} = \frac{0.01 \text{ sand} + 0.12 \text{ silt} + 0.57 \text{ clay}}{(1 \pm 0.025)}$$

Inhibiting Factors in Lychnis and Papaver:

GEORGE HARRISON SHULL, Carnegie Institution.

A cross between white-flowered and purple-flowered forms of *Lychnis dioica* L. (*Melandrium album* and *M. rubrum*), both from Germany, have given an F_1 predominantly white-flowered, though numerous previous crosses between other white-flowered and purple-flowered strains of this species have invariably produced only purple-flowered offspring in the F_1 . The white-flowered form from Germany, in crosses with a "recessive white" American strain, produced in one case a white-flowered F_1 , in another case a purple-flowered F_1 . In *Papaver Rhæas* white has usually proved to be recessive to colors, but in one instance a cross between deep red and white produced a completely whitish progeny in the F_1 , and the same result was also attained in a cross between two deep red parents. The latter experience suggests the existence of two complementary inhibiting factors, *A* and *B*, which have no effect except when co-existing in the same plant.

Inheritance in Capsella: H. HUS, University of Michigan.

Seedlings from a single plant of *Capsella Bursa-pastoris* can be classed in three groups: broad-leaved, narrow-leaved and linear-leaved. These forms occur approximately in the proportion 2:2:1. This proportion, which has been maintained for three generations, may perhaps be looked upon as a simple Mendelian splitting in the F_2 generation, of the *Zea* type, complicated by a defective inheritance ratio. This contention meets with the objection that the linear-leaved form represents a type thus far unreported.

The Origin of the Erect Cells in the Phloem of Abietinæ: M. A. CHRYSLER, University of Maine.

If a medullary ray in such a genus as *Pinus* is traced outward from xylem to phloem, it is well known that the marginal tracheids of the woody part of the ray may be seen to be replaced in the

phloem by nucleated cells which are somewhat elongated in the longitudinal direction, the so-called "erect cells" of the ray. From a study of the roots of seedlings it is found that various transitions between these erect cells and sieve-tubes occur. Groups of elongated cells provided with nuclei and sieve-plates are a common feature of the phloem of these young roots, and where such a group meets a medullary ray certain of the elongated cells become applied to the ray and become progressively shorter, forming the erect marginal cells, while the rest of the elongated cells give place to ordinary sieve-tubes. Thus from what may be called *primitive sieve-cells* the sieve-tubes are derived by elongation, and the erect cells of the ray by shortening.

Do the Abietinæ extend to the Carboniferous?

R. B. THOMSON and A. E. ALLIN, Toronto University.

The claims for the great geological age of the Abietinæ (see Jeffrey and Chrysler, *Bot. Gaz.*, p. 13, 1906) are based on the occurrence of *Pityoxylon chasense* in the Permian and on the supposed occurrence of *P. Conwentzianum* in the Carboniferous.

P. chasense was described by Penhallow in 1900. The pitting of the tracheids is of the Araucarian or Cordaitan type (1-3 seriate, alternate and hexagonal) and bears not the slightest resemblance to that of *Pityoxylon* as defined by Kraus (one-seriate, or opposite when two-seriate), or to that of an Abietinean form. Penhallow, however, placed this form in the genus *Pityoxylon* because of the occurrence of what he supposed were horizontal resin canals. A careful study of the type material has revealed that they are not resin canals but leaf traces quite comparable to those in certain Cordaites and Araucarinæ. This Permian *Pityoxylon* is, therefore, a true Cordaitan or Araucarian.

Gothan has recently shown that *P. Conwentzianum*, which is commonly attributed to the Carboniferous but whose horizon was never determined, can not be an authentic Carboniferous form.

The geological claim for the great antiquity of the Abietinæ thus fails on critical study of the two forms upon which it is based.

Ingrowing Sprouts of Solanum tuberosum: C. STUART GAGER, Brooklyn Botanic Garden.

The paper described a case in which the sprouts of a large number of potatoes grew into and through the tubers that bore them, ramifying

freely and producing roots and small tubers within the large seed tuber. The potatoes were stored in a dry room lighted with diffuse daylight. Sprouts of one tuber never penetrated an adjacent one. Investigation failed to show the presence of any enzymes by the action of which the channels of the ingrowing sprouts could have been digested, though the epidermis of the sprouts was modified so as to resemble typical glandular epithelium, thus suggesting secretion. There was positive evidence that the sprouts made their way through the tissue by mechanical pressure. Attempts experimentally to produce penetration of tubers by potato sprouts met with success, except that the sprouts were unable to penetrate through the epidermis from the outside. These experiments, in connection with the behavior of the original abnormality, led to the high probability of a reversal of polarity in the shoots. The cause of tuber-formation in general was briefly discussed, as was also the bearing of the ingrowing sprouts on the question of the mode of emergence of lateral roots.

The Gametophytes of the Kauri: ARTHUR J. EAMES, Harvard University.

The microspore contains many supernumerary prothallial nuclei. Its branching tubes penetrate the scale-base and the axis, thence crossing the space to the nucellus which is largely eroded, with portions of the endosperm. The megaspore, developing at first within "spongy-tissue," forms a club-shaped embryo-sac, bearing 6-20 archegonia. A small ephemeral ventral canal nucleus is cut off. Fertilization occurs usually in lower archegonia, the two large male nuclei being shunted from the upper egg-cells by a cap of the megaspore membrane which is thickened rather than thin as in most conifers. The pro-embryo maintains a central position in the archegonium in contrast to the condition in other groups until at least 32 nuclei are formed. Then nuclear enlargement and wall-formation ensue, filling the archegonium. The upper 20 or more cells become suspensors, the central group, consisting of a few cells, the embryo proper, and the basal tier a marked protective cap. The large core of suspensors thrust down the two lower tiers deep into the endosperm, where in further development the cap is pushed aside and degenerates.

The Gametophytes of Australasian Podocarps: EDMUND W. SINNOTT, Harvard University.

The gametophytes and embryo of *Podocarpus Totara*, *Hallii*, *nivalis*, *dacrydioides*, *spicatus* and *ferrugineus* have been investigated. Observations

on the male gametophyte add to previous accounts, but agree in general with them. In the first four species (*Podocarpus* proper) three or four months elapse between the appearance of the megasporangium and the ripening of the fruit, and the development of the endosperm, archegonia, and embryo is much as in the Abietineae. In all species, even a ventral-canal nucleus is uncommon. There are from eight to sixteen suspensors. The last two species (subgenus *Prumnopitys*) are very distinct. The reproductive process extends over sixteen months. The two very large archegonia are narrowed at the base. The fusion nucleus divides into four as it drops and the eight subsequent basal nuclei are irregularly arranged, as are the sixteen cells which follow them. The young embryo has a "penetrating cap." Both species of the subgenus *Prumnopitys* show a marked resemblance to *Cephalotaxus*, and further investigation promises interesting results as to the relationship of the two genera.

The following list of papers, from members of the society, or members of Section G, to be introduced by members of the Botanical Society of America, were received too late to be included in the printed program and were read by title:

Acidity as a Factor in Plant Ecology: F. V. COVILLE, U. S. Department of Agriculture.

The Cultivation of Trailing Arbutus: F. V. COVILLE, U. S. Department of Agriculture.

Ecology as Applied to the Revegetation of Overgrazed Range Lands: A. W. SAMPSON, U. S. Department of Agriculture.

The Relation of Soil Acidity to Plant Societies: A. W. SAMPSON, U. S. Department of Agriculture.

The Effect of a 2 per cent. Aqueous Solution of Antipyrin on the Cells of the Root-tip of Vicia faba: C. F. HOTTES, University of Illinois.

On the Acidity of Certain Cacti: H. M. RICHARDS, Columbia University.

Conditions Affecting the Production of Lycopin in the Tomato: B. M. DUGGAR, Cornell University.

Sensitivity in Meristematic Tissue: H. M. BENEDICT, University of Cincinnati.

A Botanical Survey of Hartsville, S. C.: W. C. COKER, University of North Carolina.

The Biology of the Lakes of Glacier: M. J. ELROD, University of Montana.

The Cytology of Laboulbenia chartophora: J. H. FAULL, University of Toronto.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

ON SOME RESEMBLANCES OF CROWN-GALL TO HUMAN CANCER¹

THE disease on which I shall speak to-day is known in this country as crown-gall, because it has been observed most frequently on the crowns of trees and shrubs, but it is not peculiar to this situation. It occurs also on roots and shoots. This disease has been known to cultivators and to plant pathologists for many years and has caused more or less injury to a variety of plants both in this country and in Europe. Of plants subject to serious injury may be mentioned: Roses, almonds, peaches, raspberries, grapes. Sometimes the plants are only dwarfed or crippled, at other times killed. Recovery, especially in certain species, is frequent. In Italy the attacked grape vines are said to live about four years.

It has been ascribed to a variety of causes, *e. g.*, frosts, wounds made in cultivating, insect injuries, fungous injuries, physiological disturbances, etc. The actual cause was not known until discovered by the writer and his associates. Team work on this disease has been carried on in the U. S. Department of Agriculture for the last eight years, *i. e.*, since February, 1904. The first successful pure culture inoculations were obtained in 1906. The organism was described and named by us in 1907.²

¹ Address as retiring president of the Botanical Society of America, Washington, D. C., December 28, 1911. By invitation members of the following organizations were also present: Section G, of the American Association for the Advancement of Science; Society of American Bacteriologists, and the American Phytopathological Society.

² SCIENCE, N. S., Vol. XXV., No. 643, pp. 671-673, 1907; see also *Centralb. f. Bakt.*, 2 Abt., XX. Bd.

Addresses setting forth the parasitic nature of the organism have been given before this Society by Dr. Townsend, and before the Society of American Bacteriologists and the American Phytopathological Society by myself.³ I have also twice in public addresses before the American Association for Cancer Research called attention to certain general resemblances of this disease to malignant human tumors, namely, at the Boston meeting in December, 1909 (lantern-slide address), and again in the spring of 1910 at the Washington meeting of the Association, where I showed specimens of the disease. The whole subject so far as regards the etiology of the disease was also summed up in a big bulletin published by the Bureau of Plant Industry, U.S. Department of Agriculture, early in 1911.⁴ I may assume, therefore, that this audience is fairly well acquainted with the evidence adduced by us to prove the pathogenic nature of the organism we have called *Bacterium tumefaciens*, and therefore I shall not spend any time on this phase of the subject. Those who are not familiar with the evidence can easily obtain the necessary publications and if these are not convincing they may repeat the experiments.

In a brief way I have also published on the newer discoveries upon which I am to speak to-day, *i. e.*, in a third address before the American Association for Cancer Research,⁵ an abstract of which was published by the Department of Agriculture as Circular No. 85, Bureau of Plant Industry, and in *Zeitschrift f. Krebsforschung*,

11 Bd., 1 Heft. Since that date the subject has been studied continuously. Numerous sections have been prepared, and I will show you lantern slides of photomicrographs made from some of these sections, so that you will be able to judge for yourselves as to the bearing of the evidence.

It is hardly possible to say who first noted the superficial resemblance of overgrowths on plants to animal tumors. It probably goes far back of published records, since we have in English the word "canker" applied to certain of these overgrowths, which word is only another form of the word cancer. Also in German, the word "Krebs" is applied indifferently to these overgrowths and to malignant human tumors. It is one thing, however, to find a superficial resemblance of plant diseases to animal diseases, and quite another to establish any strict analogy. In fact, as histological studies on cancer have multiplied animal pathologists have been more and more convinced that there is no real likeness between the plant overgrowths and malignant animal tumors, and this is true enough, I believe, for club-root of cabbage, the plant disease most studied in this connection. A comparatively recent statement by Alfred Fischer that the only thing they have in common is the name (Krebs) may be taken as fairly representing the current view.⁶ I shall hope, however, to show you before I am through that they have a good deal in common, so much, in fact, that I believe we have in these particular plant overgrowths a key to unlock the whole cancer situation. In consideration of these discoveries many closed doors in cancer research must now be opened and studies on the etiology of the disease must be done over with a view to finding a parasite within the cancer cell, and separating

³ Vide SCIENCE, February 12, 1909, p. 273; *ibid.*, August 13, 1909, p. 223; and *Phytopathology*, 1911, Vol. I., p. 7.

⁴ No. 213, "Crown-Gall of Plants: Its Cause and Remedy." To be had from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 40 cents.

⁵ Buffalo, April 13, 1911.

⁶ *Vorlesungen ueber Bacterien*, 2te Auflage, 1903, p. 277.

it therefrom by an improved technic of isolation. Before I show you any slides or describe further the discoveries made it will be necessary for me to refer briefly to the nature of cancer and certain other malignant animal diseases.

When I first called attention of members of the American Association for Cancer Research to crown-gall in 1909, the reply of some of the members was that while I had demonstrated crown-gall to be a very interesting disease it was evidently a granuloma, and not a true tumor. With this conclusion I can not agree. That you may understand why crown-galls are not granulomata I wish briefly to call your attention to the phenomena occurring in such diseases. As example of a granuloma, we may take tuberculosis. We have in this disease a focus of infection and source of irritation in the presence of a microorganism. Against this organism the body reacts with the formation in the immediately surrounding tissues of cell growths not unlike those which occur in the bottom and sides of wounds, namely, granulation tissue, hence the name granuloma. In this manner nodular growths arise, but these nodular growths are limited in extent of tissue involved, are produced from the tissues immediately surrounding the bacterial nest, are not vascularized, and soon become disorganized in their interior. In tuberculosis the blood vessels occurring naturally within the attacked area are obliterated and excluded from the tubercle; in certain other granulomata, *e. g.*, syphilitic gummata, the vessels are not obliterated, but they are distinct in other ways, *e. g.*, enclosed in a fibrous capsule. The disease is carried from place to place within the body by the migration of the microorganisms, either in the blood stream or the lymphatics or in some other way, *e. g.*, through the digestive tract. Wherever

these migratory organisms lodge they set up or may set up similar irritations with the production of similar nodules of granular tissue, the same being an effort on the part of the infected animal to overcome the disease. The point which I wish specially to emphasize is the fact that in these secondary infections the granular tissue which develops is formed out of the particular organ in which the parasites happen to lodge, and does not consist of cells brought to it from a distance.

In this respect cancers are quite different. Parenthetically I might stop here long enough to say that I shall for the purposes of this address use the term cancer in a loose, general sense for all malignant human tumors. First, because the crown-gall which I have studied seems to partake of the nature of different types of malignant animal tumors, and because I believe that when the cause of malignant animal tumors is discovered we shall find that many of the hard and fast lines of separation which the animal histologists have erected between sarcoma, carcinoma, etc., will be found untenable.

In cancer we have an enormous multiplication of certain tissues of the animal (epithelial, connective, etc.) which by continued growth crush and disorganize the surrounding tissues. These growths are more or less highly vascularized, and new vessels are formed as the tumor develops, but not to an extent sufficient to carry on the growth beyond a certain point. Usually there is a great excess of parenchyma cells in such a tumor and the blood vessels are not sufficiently numerous to nourish it properly, so that after a longer or shorter period (months or years) portions of it disorganize often into open wounds which are then readily infected by all sorts of secondary organisms with all the well-known disastrous results. This then is one strik-

ing difference between granulomata and cancers, but the true nature of the cancerous development becomes more evident in the secondary tumors. The mere fact that a primary cancer has developed on some part of the body does not constitute the chief danger, since one might have such a tumor for a long time without death supervening, unless the primary growth happened to be situated in or near a vital organ. What constitutes the peculiar malignancy of cancer is the tendency to form secondary growths in various parts of the body, including the vital organs, and it is this clearly recognized danger which in modern times has led to the universal recommendation on the part of competent physicians and surgeons of the early extirpation of suspicious growths, the hope being that the surgeon may be able to dissect out all the infected tissues and thus free the patient from the disease. This is the reason why, for instance, in cancer of the breast the surgeon so carefully removes not only the infected breast, but the lymphatics for long distances away, that he may, if possible, reach beyond the unseen growing cancer strands. This also is why delayed operations for cancer are seldom successful.

In case of granulomata, as we have seen, it is the parasite which migrates. In case of cancers it is the cancer cell itself which migrates, *i. e.*, some of the body cells which under some unknown stimulation have been taken out of the physiological control of the body and have become thus, as it were, parasites on their fellow cells. There are two ways in which secondary tumors are derived from the primary tumor in cancer: (1) The primary tumor growing peripherally sends out roots or strands which bore their way through normal tissues of the body, sometimes for long distances, developing from certain

portions of these strands secondary tumors. (2) Small groups of cancer cells are dislodged from the parent tumor and carried as floating islands in the blood stream or lymphatics to develop secondary tumors where they lodge. The first of these ways has been definitely established by observation; the second by inference, no connecting strand having been discovered. Naturally these secondary tumors, being derived from the primary tumor, tend to partake of the nature of the tissue from which the primary tumor has developed. For example, if the primary tumor be in the stomach, the secondary tumors are likely to contain glandular cells resembling those of the stomach, wherever they may be developed. This is such a striking peculiarity that it is often possible for the animal pathologist to tell from the study of his sections whether the cancer is primary or secondary, and, if secondary, in what organ the primary tumor is located. In case of tumors located in an organ containing all three of the embryonic layers or developed out of cell-rests of this nature we might have in the tumors a jumbled-up mass of all sorts of tissues—skin, bone, teeth, hair, muscle, nerve, etc. This at least is one method of explaining the embryomata.

Having found no parasite in the cancer cells, a majority of the animal pathologists have given up the idea that cancer can be of parasitic origin. For a generation the research workers fell back upon Cohnheim's hypothesis that cancers were due to the development of small fragments of tissue cut off from the parent layer during embryonal growth, to be enclosed in other tissues and lie dormant until acted on abnormally later in life by some unknown stimulus. But while studies of the animal body show that such separation of small portions of tissue from the germinal layer is not uncommon, research workers on

cancer are now generally agreed, I believe, that there are many phenomena connected with the development of cancer for which this hypothesis of Cohnheim offers a wholly inadequate explanation. Moreover, what induces these dormant cells to develop was never determined. A very favorite theory with cancer specialists has been that the cancer cell itself is the only parasite, and that no infections could be obtained on animals unless the living cancer cell were present. This hypothesis must now be abandoned owing to the discovery by Peyton Rous (1911) that sarcoma of chickens may be produced in the absence of cancer cells, *i. e.*, by cancerous fluid filtered free from all traces of living cancer cells. So far as I know he has not expressed any opinion as to the nature of the infection which has been separated from his ground chicken sarcomata by centrifuging and also by filtration through Berkefeld bougies, but in the light of the evidence we have secured from plants I believe you will agree with me that it can be nothing else than a living microorganism, minute enough to pass through the walls of the rather coarse filter.

In crown-galls I have not found the second method of formation of secondary tumors, namely, by the detachment of small fragments of the primary tumor to be carried in a stream and lodged at a distance. This method we should hardly expect to find in plants, owing to the fact that there is no rapid blood stream such as we find in animals, neither does it seem to be more than an epiphenomenon in tumor growth, the essential thing being the abnormal internal stimulus to cell division. The first method of propagation, namely, by strands, occurs, however, and parallels to my mind very strictly what occurs in malignant animal tumors, *e. g.*, in carcinoma, sarcoma, etc.

The existence of the tumor strand in crown-gall was overlooked for a long time. But last spring in making some sections of Paris daisy plants which had been inoculated with the crown-gall organism and bore both primary and secondary galls, I saw on cross-section a tumor-strand in the inner wood next to the pith between the secondary and the primary tumor and near the latter. This was about a millimeter in diameter and of a different color, *i. e.*, greenish, and easily observed by any one. Often, however, this strand is composed of a few cells only and difficult to find, even with the compound microscope. This, together with preoccupation on other phases of the research, must serve to explain why it was overlooked for so long a time. As soon as I saw this parenchyma out of place I said, "Here is a tumor strand!" and began to examine many other plants to see if it was at all constant—finding it visible to the naked eye near the primary tumor in perhaps 20 per cent. of the plants examined. The question then arose whether it was merely local, or could be traced for some distance and was of constant occurrence in the normal tissue between the primary and the secondary tumors. Since then many inoculated plants have been examined microscopically, and in all of them I have been able to find this tumor strand, although, as already stated, in many cases it is composed of a very few cells. In the Paris daisy it usually bores its way between pith and wood, or at the inner edge of the wood wedge in the protoxylem, apparently along lines of least resistance. (Lantern slides were exhibited, showing cross and longitudinal sections of such strands from the inoculated plants.)

On this strand are developed secondary tumors, apparently either where the food supply is most abundant or where the pressure of surrounding tissues is least,

yet possibly other factors are involved. Frequently the growth of the strand is rapid. In very juicy favorable material in 16 days from the date of the primary inoculation I have seen secondary tumors develop from such strands at a distance of 10 centimeters from the parent tumor. Often deep in the resistant wood the tumor strand is under great pressure. In softer parts the overlying tissues are split open, and the deep secondary tumor then comes to the surface. In the Paris daisy, when the primary tumor is on the stem, secondary tumors often develop on the leaves, and strands of tumor tissue have been traced in numerous instances all the way from the primary tumors through the stem into the leaf, and all stages of the development of the secondary tumors observed on many plants. This tumor strand boring its way through stems and leaves appears to be as much a foreign body as the roots of a mistletoe or the mycelium of a fungus. From these strands and from these secondary tumors we have isolated the same microorganism that occurs in the primary tumors and with subcultures from such bacterial colonies have reproduced the disease. The discovery of this strand affords a satisfactory explanation for the fact that the morbid growth usually returns after excision.

The second striking fact to which I wish to call your attention is that when the primary tumor occurs in the stem and the secondary tumor in the leaf the structure of the secondary tumor is not that of the leaf in which it is growing, but of the stem from which the strand was derived. If the discovery of the strand was an accident, this latter discovery was reasoned out, knowing what takes place in cancer. I said immediately, if this is a tumor-strand we ought to find a stem-structure in the leaf tumors, and the very first leaf tumors

cut showed typical examples of it. In secondary tumors occurring in the leaves as the result of stem inoculations the development of a stem consisting of a loose, rapidly growing parenchyma in the center, surrounded by wood wedges separated by medullary rays, beyond which is a cambium zone and a bark can be made out very clearly (slides exhibited). Sometimes these secondary tumors develop a very perfect stem structure; often, however, the stem is more or less imperfect with the inclusion of large parenchyma cells of the leaf, and with a great overproduction of stem parenchyma (medullary rays, etc.) as compared with the vascular portion. As this secondary tumor grows the surrounding leaf structure is destroyed, and eventually we may have a growth which bears no resemblance whatever to a leaf. Often, however, fragments of the leaf adhere to the surface of the tumor, and show an unchanged leaf structure.

These secondary leaf-tumors then, so far at least as regards the parenchymatous portion, are composed, in great part at least, of descendants of the originally infected stem-cells. The growth is an invasion of infected cells. To what extent neighboring uninfected cells are also involved is uncertain. The wood always shows hyperplasia, sometimes to a very marked degree in the vicinity of a stem tumor, and usually also in the vicinity of the tumor strand, especially if this is large. Are all of these wood cells infected? Probably not. I see no reason why we might not have changes in the plant distantly comparable to the inflammatory changes which take place in the vicinity of a malignant animal tumor, *i. e.*, an excessive multiplication of cells which while a part of the tumor are not its malignant portion. This must be left for further study.

This astonishing stem structure in leaves

is quite parallel to that which occurs in certain cancers of secondary origin where the structure of the primary tumor is outlined, albeit often only imperfectly. We might now inquire whether primary tumors produced on leaves do not have the same structure as those just described as secondary tumors. We have made needle-puncture inoculations on leaves of Paris daisy and have studied the structure of the tumors which develop and these do not have a stem structure but an irregular epithelioma-like structure derived wholly from the leaf, as may be seen from the lantern slide exhibited.

What happens finally in the case of cancer happens in crown-gall, namely, the tissues not being sufficiently vascularized, and composed of a great excess of soft and fleshy cells, are easily disorganized with the production of open wounds. In case of crown-galls on the daisy and many other fleshy plants after about two or three months large portions of the tumorous tissue decay with the formation of open wounds, subject to a variety of secondary infections.

It should be stated here, however, that in the crown-gall there are no abscess cavities such as we find often in granulomata or in such a disease as olive tuberculosis. Sometimes there is a multiplication of bacteria in the vessels in the vicinity of the needle puncture, but whether these are the crown-gall organisms or not we have not yet determined. Certain it is that when the tumor has begun to grow rapidly no bacteria or other granular matters have been found in the vessels or in the intercellular spaces. The causal bacteria occur inside the cells, which are stimulated by their presence to multiply with great rapidity and without reference to the physiological needs of the plants, *i. e.*, the plant has no direct control over the growth.

In these particulars crown-gall resembles epitheliomatous growths, while in the embryonal character of its luxuriant granulations and in its predilection for young plants and rapidly growing tissues it is more like sarcoma. The growth is a hyperplasia rather than a hypertrophy, although occasional groups of large cells occur. There can be no doubt as to the development of new vessels in the growing tumor. This is shown clearly by the anatomy of the secondary tumors. Whether the vessels are ingrowths from the surrounding tissues, or outgrowths from the tumor strand, or both, as would seem to be the case, must be left for further inquiry. The anatomy is unlike that of club-root of cabbage, where the growth consists of an enormous enlargement of a comparatively few infected cells.

I think, therefore, that we have in crown-galls a striking analogy to what occurs in malignant animal tumors, namely, to recapitulate, *the cell itself a disturbing force*, *i. e.*, an enormous multiplication of certain cells of the body without reference to physiological needs and in opposition to the best interests of the organism; a non-capsulate tumor, with absence of abscess cavities and of plainly visible parasites; peripheral growth and a well-developed stroma consisting of vessels and fibers; from this primary tumor the development of strands of tumor tissue upon which secondary tumors develop; in the secondary tumors a strong tendency to take on the structure of the organ in which the primary tumor has developed; frequent if not necessary origin of the primary tumor in bruises, wounds or irritated places; complete recovery if all the tumor tissue is extirpated, failure if it is not; in some cases spontaneous recovery. The chief difference so far made out is that in case of cancer cells we know nothing whatever as

to the cause of the abnormal growth,⁷ whereas in case of these overgrowths on plants we have definitely proved them to be due to the presence of an intracellular schizomycete which we have many times isolated and reisolated in pure culture and by means of which we can reproduce the disease at will.

The question now arises whether animal tumors might not be produced by means of the crown-gall organism. I might state here that while I believe cancer to be due to some intracellular microorganism which in its physiological peculiarities, action on the cell nucleus, etc., is like the one we have discovered, I do not maintain the overgrowths in warm-blooded animals to be due to this particular organism, for the reason that its maximum temperature for growth (daisy strain) is a little under the blood temperature of such animals. In thinking over the matter it seemed to me not unlikely, however, that with this organism I might be able to produce tumors in cold-blooded animals, and so four years ago I attempted to do it. I will show you only a slide or two made from an inoculated fish. I used for this purpose brook trout and in a very considerable portion of my inoculations I succeeded in producing ulcers in the deeper tissues where the needle entered. In this instance the needle entered the belly wall of the fish. The wound healed externally, but at the end of 21 days when the trout was dissected there was a well defined inner growth (proliferation nodule) in the connective tissue between the muscles with formation of giant cells. There were also when dissected two external sore spots,

⁷ "Some unknown force, the essential nature of which has so far completely escaped our knowledge and our comprehension, is capable of calling forth this latent power of proliferation, and the germ [cancer cell] begins to grow out of itself, like a seed that has been buried in the ground." (Dürck.)

one below the pectoral fin and the other below the anal fin, both of recent occurrence, but no throat or gill ulcers in this fish. Similar growths were obtained in the eye-socket. I showed sections cut from one of these ulcers to one of the most distinguished research workers on cancer in this country and he said "if we had this in man we should call it sarcoma." (Slides exhibited.) I propose to repeat and extend the work on trout and therefore will say but little about this phase of the investigation.

In conclusion I wish to call attention to some of the peculiarities of the microorganism (*Bacterium tumefaciens*) as determined by our cultural work. As well known to many of you, we prosecuted our studies upon the crown-gall for two years before we were able to isolate the parasitic organism. Ten years previous to this I spent six months on the subject with a similar negative result. Two obstacles of which we were unaware blocked the way. In the first place the organism in a viable form occurs in the tumor tissue of the daisy in small numbers only. If inoculations are made from crown-gall tissue, using about that amount of tissue we are accustomed to use for other bacterial plant diseases, and also for many animal diseases, the chances are that no colonies of the parasite will be obtained upon the plates. I have no doubt now that we made dozens of plates—yes, I might say dozens of separate sets of poured plate cultures, on which not a single colony of the right sort developed. It was only when we learned to inoculate our bouillons and agar plates with large quantities of the tumor material that we were able to obtain a sprinkling of colonies of the right organism. From a young, rapidly growing tumor it is always possible to obtain the organism with proper technic and sometimes in pure cultures, but

often only by using a hundred, a thousand, or a hundred thousand times too much material, if one were working with other organisms. The second obstacle is the fact that the living bacteria in the tumor tissue occur for the most part in a paralyzed condition, either as involution forms or in some other form which does not grow readily when plates are made. Cultures were made every few weeks from crown-gall tissue for two years and numerous and various bacteria were obtained on these plates, pricked off for sub-culture, studied microscopically and culturally, and inoculated into the plant with negative results, these organisms being the saprophytes which usually accompany crown-gall. The plates were usually discarded after three or four days, and so the work went on. If, however, one inoculates copiously as described, and waits a week or ten days for the paralyzed organisms to recover their vigor, he will then obtain colonies of the parasite.

Two questions arise: (1) Why does an organism which produces such striking results occur in the tissue in such small numbers? (2) What paralyzes it so that when agar plates are made from the tissues the colonies do not appear until the fourth, fifth, sixth, eighth or tenth day, and sometimes not until the twentieth day? These questions have received a good deal of thought. After a time we discovered that when the organism is grown in bouillon or other media containing sugar an acid is produced, and it then occurred to me that this acid might be the cause of the death of a large proportion of the organisms in the cells, and of the paralyzing of the remainder. Peptone water flask cultures of the organism were then grown in the presence of sugar and turned over to the chemist, who reported that the acid present was acetic acid. We found that after a time all the organisms in such cultures

were dead, and a microscopic examination showed that a large proportion of them occurred in the form of irregular club-shaped or Y-shaped bodies, *i. e.*, they had passed over into involution forms preceding their death. Subsequently we found that on adding dilute acetic acid to fresh cultures of the organism either on agar or in bouillon we could at will produce these involution forms. Ordinarily it was found on making poured plates from such cultures that all the organisms were dead, but by further experimenting we learned that if we added just the right quantity of acid, involution forms were produced and a portion of the bacteria killed, but that some remained alive and those which remained alive were paralyzed, coming up on the agar plates in the same slow manner as those from the interior of the tumors. I should have stated that although the organism comes up slowly from the crown-gall on agar-poured plates, sub-cultures from such colonies grow as readily as from any other easily cultivable organism, *B. coli*, for example, showing clearly that the initial slow growth is not a peculiarity due to differences in culture-media or inherent in the organism, but only one due to its previous environment in the plant cell.

Do the same phenomena occur in the plant cell? Recently from crown-gall of daisy grown for the purpose, the chemist has isolated for us an acid which he says is acetic acid. We have also found in the tissues numerous bacterial Y-shaped bodies, such as occur in our flasks when acetic acid is present. I think, therefore, we may assume, tentatively, at least, that an acid in small quantities is formed also in the cells of the crown-gall as a by-product of the bacterial growth, and that after a time this acid stops the growth of the multiplying bacteria within the cells ex-

actly as it does in the flask cultures, causing them to take on involution forms and killing the majority.

There is, as I conceive, a very delicate balance between the parasitic bacterium present in the plant and the activities of the plant cells. The cells of the plant are not destroyed by it, but only stimulated into rapid and repeated division. Upon its entrance into a cell, which must usually be by wounds, in our own experiments by needle-pricks, we may conceive the micro-organisms to multiply rapidly for a short time. The acid developed by this multiplication then inhibits the further growth of the bacteria, causing the appearance of Y-shaped bodies and the death of a certain proportion of the bacteria, sometimes nearly or quite all of them. The membrane of the bacterial cells which are killed is now permeable, and the bacterial endotoxines diffuse out into the cell. The nucleus of the cell now immediately divides, under the stimulus either of the acid or of the aforesaid endotoxines, or possibly from an excess of carbon dioxide due to the bacterial growth. There can be no doubt, I think, that carbon dioxide exists in excess in these cells, because the crown-gall tissues contain an excess of chloroplasts in the absence of any other visible means of obtaining this necessary food. These chlorophyll bodies are so abundant as often to give a distinct green color to deep tissues wherein we would ordinarily expect to find but few chloroplasts.

The next difficulty is to explain why the paralyzed bacteria carried over into the daughter cells suddenly begin a new growth. This can result, I think, only from the pouring out into the cell at the time of division of a fluid which was not previously present in it, namely, the nuclear sap which must flood the cell as soon

as the nuclear membrane disappears. Whatever the explanation may be, the bacteria take on a new growth for a short time in the daughter cells with the reproduction of the already outlined phenomena. In this way occurs within a few weeks or months an enormous overgrowth of the tumor tissue with the development of strands and of secondary tumors as already described. Using rapidly growing favorable plants, it is possible by means of a few needle-pricks carrying in the parasitic organism to obtain a tumor as large as one's fist in as short a period as six weeks. Ordinarily, however, growth is slower. Dr. A. P. Matthews, to whom I am indebted for suggestions respecting the effect of the nuclear sap on animal cells, tells me he has observed in case of the entrance of sperm cells into the eggs of star fish that the sperm retained its original form until the breaking up of the nuclear wall and the diffusion of the nuclear sap into the egg cell, whereupon the sperm took on a rapid growth.

Although we are able by means of poured-plate cultures to isolate the organism in a pure state from young crown-galls and reproduce the disease at will, we can not readily demonstrate the presence of the organism in the tissues by means of the microscope. If the bacteria were as readily seen in crown-gall tissues as they are, for instance, in the tuberculosis of the olive, the cause of the disease would have been discovered long ago. The organism is not an acid-fast organism, and when it stains at all a great variety of cell inclusions also stain and some of these derived from the cell protoplasm or from special parts of the nucleus are confusing. Its staining is also complicated by the fact of its passing over so readily into involution forms which are proverbially difficult to stain. I have seen occasionally inside of

the cells of the crown-gall motile, flexuous, rod-shaped bodies which I take to be this organism, and we have occasionally stained in small numbers in the cells bodies which closely resemble rod-shaped bacteria, but ordinarily they occur in such small numbers or take stains so vaguely and imperfectly that this method of demonstration would not be convincing to an outsider. Also sometimes we find small groups of cells filled with what appear to be semi-disorganized bacteria, as if here the bacteria had gained the mastery for a short time and then degenerated. We have not in the whole eight years obtained any very satisfactory slides, although many attempts have been made, using a great variety of fixing agents and of stains. As I have stated elsewhere, if we had depended on the microscope alone we should not have been able to work out the etiology of this disease, and the plain demonstration of the parasite in the cells must await, I think, the development of some special technic of staining whereby we may be able to mordant the bacteria in such a way that they shall take one color while the contents of the host cell takes another. Even in case of the Y-shaped bodies one is seldom able to demonstrate them in the stained cells. We have obtained the best results by an indirect method, namely, by taking clean slides and burning the surface free from all possible organisms, then putting on a little distilled sterile water, and putting into this sections of young crown-galls taken from a portion of the tissue pared free from all exterior parts, allowing the contents of the cut cells to diffuse into the water for an hour, then removing the sections, drying the fluid and staining the slide. Examining such slides under the oil-immersion objective in course of a day one finds a good many such Y-shaped bodies. We have found the best method to be

the systematic search of the whole slide, passing it back and forth under the objective. Searched in this way, about one field in four yields a Y-shaped body. Bacterial rods have also been obtained from the tissues in this way.

Various researchers on cancer have mentioned finding rod-shaped and Y-shaped bodies in cancer cells. For example, Dr. Borrel, of the Pasteur Institute in Paris, and Dr. Reese, working in the cancer laboratory at Buffalo.

These plant neoplasms contain both small-celled and large-celled parenchyma and a variety of other tissues, *e. g.*, vessels and fibers. Cell division is sometimes so rapid that the cell wall can not keep pace. (Slides shown.) Frequently two and sometimes more nuclei are present in a cell. A portion at least of the cell divisions are by mitosis; but not all, it would seem. Some queer things take place in the cells. We are now studying the mechanism of cell-division in these tumors and are not ready to report.

To conclude, suppose we had in human cancer as its cause a microorganism multiplying in small numbers within the cell, having a definite action on cell nuclei, readily inhibited by its own by-products, losing virulence easily, passing quickly over into involution forms which are difficult to stain, and which are so paralyzed that only a very small portion will grow at all, except from the very youngest cells, and these only after a considerable period of time has elapsed, and further suppose that for their growth some very special technic of isolation, or some peculiar kind of culture media were necessary, then we should have precisely the same difficult conditions of isolation and determination as have confronted us in case of this similar overgrowth of plants, and ample explanation of why expert animal pathologists have been unable to see the parasite.

in their sections, and unable to cultivate it on their culture media, and consequently, have very generally reached the conclusion that it does not exist. Granted the existence of such an organism, and we have a ready explanation for the growth of the cancer cell in defiance of the physiological needs of the organism. The hitherto inexplicable occasional change in the nature of the cell-growth of tumors, *e. g.*, from epithelial to carcinomatous and from carcinomatous to sarcomatous also finds its explanation in the presence of a sensitive microorganism growing usually in the kind of cell originally infected but capable under certain circumstances of invading other types of cells.

ERWIN F. SMITH

U. S. DEPARTMENT OF AGRICULTURE

[The illustrations accompanying this address will be reproduced at an early date in a bulletin to be published by the U. S. Department of Agriculture.]

THE ROYAL ENGINEERING COLLEGE AT CHARLOTTENBURG-BERLIN

DIE Königliche technische Hochschule zu Berlin¹ is the leading school for higher learning in technical subjects in the German Empire. It is not an imperial institution; but was founded and is supported by the state of Prussia. It is under the immediate control of the Prussian University of Public Instruction.

This school covers, in general, the same ground as the Massachusetts Institute of Technology, the Troy Polytechnic, the Stevens Institute and the schools or colleges of engineering in our own state universities, including, like that of Illinois,

¹ This term has been translated into English in many different ways: the Royal Technical College; the Technical University; etc. I prefer the one I have placed at the head of this article.

for instance, a department of architecture.²

The constitutional statute as revised in 1882 declares it to be "the purpose of the Technische Hochschule to furnish a suitable higher training for technical careers in the public service of the state and the municipalities as well as for private practice in the industrial life of the nation; and further (and this is very important) to cultivate the sciences and the arts which underlie the field of technical instruction."³

The school is divided into six departments: Architecture; Civil Engineering; Mechanical and Electrical Engineering; Marine Engineering and Construction; Chemistry and Metallurgy; and General Science, including Mathematics and the Natural Sciences.

The requirements for admission have in common for all departments the certificate of graduation from a gymnasium, real-gymnasium, or higher realschule; *i. e.*, the ordinary preparatory classical or scientific college of the German empire.⁴

A year's practical work in a shop or factory is furthermore required of those who wish to take the technical degree in mechanical or electrical engineering and in a ship yard for those who wish to take marine engineering. A shorter time of practical work suffices for the candidates

² The engineering school at the University of Illinois was organized along similar lines to those of the school at Charlottenburg. Its first dean was Dr. Nathan C. Ricker, who was a student in Germany in his early years.

³ The German never loses sight of the fact that the promotion of our scientific knowledge by original investigation and research is fundamental to all successful organization of higher education.

⁴ The normal age for completing this preparatory course is 18 years. The average age, however, and the age of the majority of the graduates is nearer 19; although many finish the course at 17 and a few at 16.

in chemistry and metallurgy. This practical experience takes the place of the school shop work in our American institutions. Half of this work may be made up in vacations during the course so that the whole period of study after the preparatory school is finished is lengthened only six months by this provision.

The course of the engineering school is four years in length and leads up to a final examination, the successful completion of which entitles one to the degree of Certified Engineer (*Diplom-Ingenieur*).

The degree of Doctor of Engineering (*Doktor-Ingenieur*) may be obtained without further attendance on systematic courses of instruction upon the presentation of a satisfactory scientific thesis "which demonstrates the capacity of the candidate for independent scientific work in the technical field," and the passing of an oral examination.

As it ordinarily requires several months' hard work to prepare such a thesis, the candidate rarely obtains his doctor's degree within a shorter time than one year after his degree of certificated engineer is obtained; though the law does not require any specified time to elapse between the taking of the two degrees.

The thesis which is required in connection with the examination for certificated engineer will not be accepted as a doctor's thesis.

With this brief statement of fact it may be interesting to compare the course and requirements of the Royal College at Charlottenburg with our own institutions.

The normal German boy should enter the gymnasium, or *realschule*, at nine years of age and complete the course by the time he is eighteen. If he then puts in a full year in a shop he will be nineteen when he enters the Engineering College with his shop work completed. By the time he has com-

pleted his four-year engineering course and obtained the degree of certificated engineer he will be twenty-three. By spending one year more he can take his doctor's degree at twenty-four.

As seen from the above account, he can shorten this time materially. First, by completing his preparatory course at 17 instead of 18, which is easy for the capable and industrious boy; second, by putting half of his practical year into the long vacations, thus saving six months; and, third, by completing his thesis for the doctor's degree in six months which is also thoroughly feasible. A student who pursues this course could obtain his doctor's degree at twenty-two instead of twenty-four.

On the other hand, the average boy takes until he is nineteen to complete his preparatory course; wastes six months, and often a year, in "enjoying his academic freedom" and takes more than the schedule time for the doctor's degree, arriving at that point in his twenty-fifth or twenty-sixth year.

Now, take the American boy who is looking forward to the doctor's degree in engineering at, say the University of Illinois. Suppose he graduates at a good Chicago high school. He will be eighteen years old if he has pursued the normal course, *i. e.*, enters the primary school at six years of age; completes the eight grades and enters the high school at fourteen, taking the regular time of four years for the full course for graduation.

He must now take four years for the ordinary course, leading to the bachelor's degree in engineering. By this time he is twenty-two. He must then take three years' graduate work for the degree of doctor in engineering, making him twenty-five years of age—*i. e.*, one year older than the German who takes the normal time.

The American boy can abridge his course one full year by completing his preparatory course at seventeen, as he can easily do if he has brains and industry. He may cut the college course by another six months if he is specially well prepared, able and industrious and may thus take his doctor's degree at twenty-three and one half.

On the other hand, the average boy slips a cog somewhere like his German brother and loses time along the way. Our statistics show that the average age of the freshman entering the University of Illinois is a little over nineteen instead of eighteen as it should be; or seventeen as it might well be; or even sixteen, as it sometimes is. Many students lose again in college and must return for a part or the whole of a fifth year before getting their first degree. Such students, however, would rarely be considered as candidates for the doctor's degree, nor would they care themselves to attempt it.

It will thus be seen that the courses in the two countries run along somewhat parallel lines so far as the formal requirements are concerned.

The German *realschule*, or *gymnasium*, is, on the whole, a more thorough and effective center of training than the American high school. The teachers are better educated and the discipline is more severe. The German boy *must work* or he is thrown out of the school. The American boy is permitted to dawdle along and fool away a good portion of his time without running any serious risk of dismissal or even of being required to take the year's work over again.

In the best American high schools with properly educated teachers the American boy has a *chance* of acquiring as good a training as his German brother, or would have such a chance, if the lazy idlers in his

class could be put in a division by themselves. Under the actual circumstances, he must use one year in college, and some high authorities would say two years, in order to get as far along in real mental training and effective knowledge as the German boy when he leaves the preparatory school.

The German engineering school gives little attention to the so-called general subjects in its curriculum. These are taken care of in the preparatory school. No languages or history appear, among the required or elective subjects. Certain general subjects which have a practical value for the engineer, like commercial law, patent law, finance, political economy, etc., are listed among the possible courses to be chosen, while opportunity is also offered for courses in foreign languages—French, Russian, English, etc.

To put our American engineering schools on a par with the German as educational institutions, we must first of all improve the quality of our preparatory instruction. This will be done, not by lengthening the college course, or by merely requiring a bachelor's degree for admission; but by insisting that the student who wishes to take up engineering studies should have a thorough grounding in the elements of a liberal education, including the mother tongue, foreign languages, mathematics, history and the natural sciences. This can all be acquired by the time the student is eighteen or nineteen years of age without spending three or four years in college after leaving the high school. Perhaps a good compromise might be effected for a time by requiring one or two years of general study in an arts course as a preliminary requirement for admission to the technical courses. If mathematics and physics, chemistry and drawing, were prescribed for this college

period it might fairly enough be fixed at two years. In this way, a five years' course, after leaving the high school, could be worked out leading to a technical degree, which might then in one more year lead to a doctor's degree. The present situation is one of unstable equilibrium. Our ultimate hope lies in the development of the public high school into an effective tory instruction.

It is interesting to note how many men come up at Charlottenburg for their final examinations and the diploma and for the doctor's degree during the year. The attendance of matriculated, *i. e.*, regular students at the Hochschule during the year ending June 30, 1911, was 2,060 (average for the two semesters). Of these, 336 passed successfully the examinations for the degree of Certificated Engineer—roughly one in six of the total number. Forty-two took the doctor's degree in engineering, *i. e.*, one in fifty.

During the week I spent in a careful study of the Hochschule and its workings I was greatly impressed by the emphasis laid on training the men to independent methods of work, and by the manifest desire to turn out, not highly trained artisans or mechanics, but independent thinkers within the field of technical pursuits—men who because of their mental development will be able to lead in whatever field they may enter. EDMUND J. JAMES

CHARLOTTENBURG-BERLIN, GERMANY,
January 1, 1912

WILLIAM EMERSON DAMON

THE death of William Emerson Damon on December 1, in Windsor, Vermont, at the age of seventy-three, recalls to his friends memories of his early days, when his enthusiastic devotion to natural history studies in general, and more especially to ichthyology and pisciculture, caused him to become the leading spirit in the establishment of New

York's first aquarium. This first venture was a department of Barnum's old Ann Street museum. It was due to Mr. Damon's persuasion that the irrepressible showman was induced to undertake this enterprise; however, unexpected difficulties were encountered in securing specimens from the South Atlantic, but few of the fish being alive when they reached New York. Finally a special craft was chartered and placed under Mr. Damon's immediate control.

This was in 1863, during our Civil War, and some very interesting details regarding this expedition have been furnished by Professor Albert S. Bickmore. Barnum, who had just acquired the "Aquarial Gardens" in Boston, wrote to Professor Agassiz, of Harvard, that if the latter had an assistant whom he would like to send along to collect specimens for the Museum of Comparative Zoology in Cambridge, all facilities would be accorded to him. This offer was accepted by Agassiz, who selected Professor Bickmore as his representative. The little fishing-smack chartered for the trip was given the high-sounding name *Pacific*. Its equipment, however, was of the simplest, not even a chronometer being on board, so that when, after coasting along until Cape Hatteras was reached, the course was laid due east, and the ship passed out of sight of land, there was no means of determining its exact position. Fortunately, half-way toward Bermuda, an East-Indiaman was met, and the adventurous seamen were able to learn their precise latitude and longitude.

On the arrival of the little craft in Bermuda, Professor Bickmore writes:

As we came near Port Hamilton, the principal harbor, a number of native boats put off to board us, for what purpose we were at a loss to imagine, until one more skilfully managed than the others came alongside, and its black crew offered to aid us as agents. "What for?" we asked; to which came the rejoinder: "Why, when we saw how you could sail in a strong breeze, we felt sure you were a 'blockade-runner' loaded with tobacco."

When the entirely peaceful intentions of the newcomers were made plain, the authorities facilitated their operations and some 600

fine specimens were secured, and safely brought to New York. The beautiful Bermuda Islands were then but little known to New-Yorkers and the enthusiastic account of their charms given by both Mr. Damon and Professor Bickmore undoubtedly helped much to make that region popular with New-Yorkers and Bostonians.

To this first aquarium venture succeeded another, which was housed for some years in a building on the site now occupied by the Herald Square Theatre. A most appropriate banquet celebrated the opening of this aquarium, the menu of fifty-three courses consisting exclusively of fish. With this foundation Mr. Damon was largely interested and when, finally, the present well-equipped aquarium in Battery Park was established his advice and council were eagerly sought and he was given a deciding voice in the choice of the director.

There can be no doubt that if Mr. Damon could have found an opening enabling him to devote all his time and energies to natural history he would have earned a world-wide reputation in this field, but a leading jewelry house would have lacked his valuable services as part owner and credit-man, services extending for forty years. Nevertheless, his interest in these studies was always great and he found time to make many contributions to the progress of this branch of science. His book entitled "Ocean Wonders" records a number of very interesting experiences gained during his early researches. During his business career he was exceedingly fond of making pedestrian excursions in the environs of New York City, and thus acquired an exceptionally thorough knowledge of the formation of the land in this territory.

His lively interest in scientific pursuits and the recognition accorded him in the scientific world is shown by his membership in the New York Microscopical Society, the Royal Microscopical Society of London, the New York Mycological Club, the Scientific Alliance of New York, the New York Naturalists' Club and the New York Zoological Society. He

was also a member of the New England Society. He is survived by a widow.

GEORGE F. KUNZ

MEMORIAL TO MRS. ELLEN H. RICHARDS

THE third annual meeting and luncheon of the Home Economics Association of Greater New York, held on Saturday at the National Arts Club in that city, took the form of a memorial to Mrs. Ellen H. Richards, late of the Massachusetts Institute of Technology and president of the Lake Placid Conference of Home Economics and the American Home Economics Association. The literary program at the luncheon was in charge of Professor Helen Kinne, of the School of Household Arts, Teachers College, the president of the New York association. At the last annual meeting Mrs. Richards was present as the guest of honor and gave an address on the "Conservation of Human Resources." Miss Kinne in introducing one of the speakers, said that probably there was no member of the club whose life had not been touched and quickened by Mrs. Richards. For herself, she said, she had two mental pictures of Mrs. Richards, one in her laboratory at the Institute of Technology, and the other in her home with the flowers.

The first speaker was Miss Margaret Maltby, professor of physics in Barnard College. She told of her first contact with Mrs. Richards while she studied at the Institute in 1887 and of the constant thoughtfulness of the only woman teacher there for the girl students. She said:

Mrs. Richards in an unusual degree combined the qualities of the prophet, the scientist and the practical optimist. She was constantly anticipating lines along which advance would be made. Her imagination was based on a solid foundation of scientific fact and her prognostications were seldom wrong. Her interests were broad and were not confined to any one science. This was shown by her study of medical books, by her use of the weather charts which came daily to her home, and by her activities in many scientific societies. With all this there was a sense of proportion, an instinct for what was feasible, a practical method of attack, a wonderful power of analysis, which was

often astonishing. She was a pioneer in scientific management in the case of the individual as well as of the institution and aimed for the maximum of efficiency for the individual and the race. Environment as expressed in food, shelter and clothing was but the means to an end, the betterment of the race.

Mrs. Mary J. Lincoln, first principal of the Boston Cooking School, told of Mrs. Richards's help in the early days of that institution (now merged with Simmons College), how she sometimes lectured at the school and more often the pupils went to her. At a later period when Mrs. Lincoln was preparing a text-book for public schools, Mrs. Richards gave advice and read proof. "Be careful, that may not be so in ten years," "Better say, 'so far as we know now,'" were some of her comments which prove how her own words were to be trusted.

Of particular interest was the announcement made by Mrs. Caroline Weeks Barrett, chairman of the Ellen H. Richards Home Economics Fund committee. This committee is soon to make definite announcement regarding the memorial to Mrs. Richards which will take the form of a fund to be administered for research and publication for advancing the interests of the home.

We could not think of putting up a dead thing as a memorial to Mrs. Richards, a bronze tablet or even a building. She was a living argument for home economics. How shall we keep her alive? We must give her earthly immortality through a living memorial, something which shall continue to do Mrs. Richards's work with Mrs. Richards's spirit. For this woman who believed in the impossible and helped it to come to pass it is not impossible for us to raise a hundred thousand dollars in dollar subscriptions from those who have felt her influence, to be invested by a board of trustees and used under their direction to establish the *Journal of Home Economics* and later for lectureships, research and publication according to the needs of the time. The collection of funds by personal canvass is soon to be initiated in a country-wide campaign which will enlist committees numbering over a thousand persons who will seek this uniform democratic contribution from men and women interested in advancing the welfare of the home through a memorial to this

woman who as scientist and social engineer did so much for the home.

SCIENTIFIC NOTES AND NEWS

Among the British New Year's honors are knighthoods conferred on Professor W. F. Barrett, F.R.S., formerly professor of physics in the Royal College of Science, Dublin, and Professor E. B. Tylor, F.R.S., emeritus professor of anthropology in the University of Oxford.

M. LIPPMAN has been elected president, and Professor Guyon vice-president, of the Paris Academy of Sciences.

THE Academy of Sciences at Bologna has awarded the Élie de Cyon prize of 3,000 lire to Professor E. A. Schäfer, of Edinburgh.

THE senate of St. Andrews University has resolved to confer honorary degrees *in absentia* upon gentlemen chosen for the degrees on the occasion of the celebration of the five hundredth anniversary of the foundation of the university in September last, but who were unable to be present. Among them is Dr. Charles D. Walcott, geologist, and secretary of the Smithsonian Institution.

COLUMBIA UNIVERSITY has designated as Jesup lecturer for 1912-13 Professor H. T. Morgan, of the department of zoology. His lectures will be delivered at the American Museum of Natural History. Professor W. P. Montague, of the department of philosophy, has been appointed to deliver the Hewitt lectures at Cooper Union in the spring of 1913.

MR. RAYMOND A. PEARSON has resigned the office of commissioner of agriculture of the state of New York.

PROFESSOR JOHN B. WATSON, of the Johns Hopkins University, has recently been granted a three years' appointment as a research associate of the Carnegie Institution of Washington, in order that he may study the migratory and other instincts of the sea-gulls of the Tortugas, Florida.

AN expedition to Montego Bay, Jamaica, is about to be undertaken by the department of marine biology of the Carnegie Institution of Washington. In addition to the director, the

investigators will consist of Professors David H. Tennent, Gilman A. Drew, Robert Tracy Jackson, H. L. Clark, H. E. Jordan, R. L. Cary and E. E. Reinke. Mr. George Gray, of Woods Hole, will accompany the expedition as collector.

PROFESSOR M. M. METCALF, head of the department of zoology of Oberlin College, has been granted leave of absence for the second semester to carry on research work in the Marine Laboratory of the University of California.

FREDERICK STARR, associate professor of anthropology at the University of Chicago, returned on January 1 from a four months' journey through Korea. Professor Starr has been made a Commander of the Order of Leopold II., by King Albert, of Belgium.

MR. WILFRED H. OSGOOD, of the Field Museum of Natural History, accompanied by Mr. Malcolm P. Anderson, sailed on January 27 from New Orleans to Colon, *en route* to the west coast of South America and the Peruvian Andes. They will spend six to nine months collecting mammals and birds and studying the general faunal conditions in that region.

PROFESSOR C. V. PIPER, of the United States Department of Agriculture, has returned to Washington after a year's absence in the orient. Six months of this time were spent in the Philippine Islands investigating the possibilities of producing hay in the Philippines for the use of army horses. The remaining time was devoted mainly to a study of the agricultural conditions in India. Professor Piper brought back with him a large lot of seeds, principally grasses and legumes, which promise to be of value in the southern states and West Indies.

THE eighth lecture of the Harvey Society series will be delivered by Professor T. W. Richards, of Harvard University, on Saturday, February 3, 1912, at 8.30 p.m., at the New York Academy of Medicine, 17 West 43d Street. The subject is: "The Relations of Modern Chemistry to Medicine."

PROFESSOR W. L. TOWER, of the University of Chicago, delivered a lecture on December

20 to the members of the Science Club of the Kansas State Agricultural College at Manhattan on "The Modification of the Germ Plasm and Inheritance."

PROFESSOR D. H. TENNENT, of Bryn Mawr College, gave an afternoon and an evening lecture at Oberlin, on January 17, upon "Variation and Heredity in Echinoderms," basing his discussion on his hybridization experiments and the cytological analysis of their results.

DR. BARTON WARREN EVERMANN, chief of the Alaska Fisheries Service, U. S. Bureau of Fisheries, lectured before the Buffalo Society of Natural Sciences on Friday evening, January 19, on "The Alaska Fur-seal and the Fur-seal Question." He strongly approved the government policy of killing the surplus 3-year-old males, after making ample reservations for breeding purposes.

PROFESSOR LAFAYETTE B. MENDEL, of Yale University, gave an illustrated lecture before the Columbia University Chapter of the Sigma Xi Society on January 18, on "Nutrition and Growth."

PROFESSOR J. McKEEN CATTELL, of Columbia University, gave the foundation address at Indiana University on the morning of January 19. In the afternoon he spoke before the faculties on "Grades and Credits," and in the evening addressed the Society of Sigma Xi. On January 22, he gave an address before the faculties of the University of Illinois on "The Administration of a University," and in the evening discussed the question with the committee charged with framing a constitution for the university. On January 5, Professor Cattell gave an address at Lehigh University and in the evening addressed the faculties of Lehigh University and Lafayette College.

THE department of Natural History of the College of the City of New York announces the following public lectures, which will be given on Thursday afternoons at 4 o'clock:

February 8—Professor N. L. Britton, director of the New York Botanical Gardens: "Scenic and Floral Features of Cuba."

February 29—Dr. C. H. Townsend, director of

the New York Aquarium: "The Voyage of the *Albatross* to the Gulf of California."

March 7—Dr. C. William Beebe, curator of birds, New York Zoological Park: "Adventures of an Ornithologist in the Far East."

March 21—Dr. R. H. Lowie, assistant curator of anthropology, American Museum of Natural History: "An Ethnologist in the Field."

THE Naples Table Association for promoting Laboratory Research by Women calls attention to the opportunities for research in zoology, botany and physiology provided by the foundation of this table. The year of the association begins in April and all applications for the year 1912-13 should be sent to the secretary on or before March 1, 1912. A prize of \$1,000 has been offered periodically by the association for the best thesis written by a woman on a scientific subject, embodying new observations and new conclusions based on an independent laboratory research in biological (including psychological), chemical or physical science. In April, 1911, the prize was named the Ellen Richards Research Prize. The sixth prize will be awarded in April, 1913. Application blanks, information in regard to the advantages at Naples for research and collection of material, and circulars giving the conditions of the award of the prize will be furnished by the secretary, Mrs. A. D. Mead, 283 Wayland Ave., Providence, R. I.

THE chairman of the finance committee of the New York Academy of Medicine, in sending out to members the treasurer's report, states that \$110,000 has been raised by subscription from about one fourth of the members, and that it is expected to collect about double that sum within the academy in order to pay for the real estate purchased as a site for the proposed enlarged building, before appealing to the general public for funds.

THE extension of the Horniman Museum, Forest Hill, consisting of a lecture hall and a new library, the gift of Mr. E. J. Horniman, son of the donor of the museum, was opened on January 27, by Sir Archibald Geikie, K.C.B., president of the Royal Society.

MR. ROBERT WILCOX SAYLES, in charge of the geological section of the Harvard University

Museum, has given the sum of \$5,000 to the Seismological Society of America, to aid in the publication of the Society's *Bulletin*.

THE Field Museum of Natural History, Chicago, has acquired recently, through purchase, the herbarium and botanical library of the late J. H. Schuette, of Green Bay, Wisconsin. The collection comprises 15,000 to 20,000 carefully prepared and fully labelled herbarium specimens, principally from Wisconsin, well representing the flora of the state. In addition to the general collection there is a valuable series of native American roses, the particular group of plants in which Mr. Schuette was for many years deeply interested and to which he gave critical study.

AMONG the dispositions of the will of Dr. O. M. Lannelongue, professor of surgery at the University of Paris, are the following: An annual sum of \$100 is left to the University of Paris, the same sum to the Faculty of Medicine for assisting necessitous students, and a sum of \$35,000 for the establishment of a museum, for which material had already been collected, in his native town, Castéra-Verduzan. Various other benefactions are conferred upon the town of Castéra-Verduzan. The residue of the property is to go towards the creation of some national or international work of a social or scientific order.

MR. CHARLES G. ABBOT, director of the Smithsonian Astrophysical Observatory, has returned to Washington from Bassour, Algeria, where he has been making astrophysical observations, in regard to the solar constant of radiation. The observing station in Bassour was established in July, 1911, when Mr. Abbot and his field assistant, Professor Frank P. Brackett, of Pomona College, arrived in Algeria, and observations were continued until the end of November. From previous work at Washington, Mount Wilson and Mount Whitney, it had been determined that the sun was probably a variable star, and that apparently its radiations frequently fluctuated from 2 to 5 per cent., during irregular periods of from five to ten days duration. Although strongly indicated by the work on Mount Wil-

son, the result was so important that it seemed necessary to test it further, by means of simultaneous independent observations held at Mount Wilson and some other high altitude station remote from there, where an equally cloudless atmosphere existed. These duplicate observations would eliminate all errors due to local atmospheric conditions. Mr. Abbot made complete determinations of the solar constant of radiation for forty-four days, in Bassour, while his assistant, Mr. L. B. Aldrich, made similar measurements at Mount Wilson, Cal. The two observing stations were separated by a distance nearly equal to that of one third the circumference of the earth. Unfortunately some cloudy weather was encountered at each of the stations, but the records of about thirty days will be available for comparison. If it seems necessary to make additional measurements it will be possible to continue the work this year, during June, July and August.

MORE than 200,000,000 barrels of oil, with a value of nearly \$128,000,000, were produced in the United States last year, according to David T. Day, of the United States Geological Survey, in an advance chapter on petroleum from "Mineral Resources of the United States" for 1910. The petroleum industry in the United States, says Dr. Day, has been characterized by a phenomenal increase each year for the last four years. Each year's gain over that of the year before has been so remarkable as to lead to the belief that the limit of production had been reached, but the increase has continued rapidly. After varying between 50,000,000 and 60,000,000 barrels annually in the decade between 1890 and 1900, the oil output was over 63,000,000 barrels in 1900 and increased to 88,000,000 barrels in 1902. In 1903 it passed the 100,000,000-barrel mark, in 1904 it was over 170,000,000 barrels, and in 1905 nearly 135,000,000 barrels. After a slight decline in 1906 the output rose again, in 1907 reaching 166,000,000 barrels. It was 178,000,000 barrels in 1908, 183,000,000 barrels in 1909, and 209,556,048 barrels in 1910, a gain of 14 per cent. over the record output of 1909. This brought

the total output since the beginning of the petroleum industry to more than two billion barrels. The United States is now by far the greatest oil-producing country; in fact, it produces more than all the rest of the world together. In 1910 the wells of this country yielded nearly 64 per cent. of the total production, Russia scoring a very poor second with about 70,000,000 barrels, or 21 per cent. The production of other countries is comparatively negligible, the third on the list, Galicia, contributing only 3.87 per cent. of the total. The excess of the petroleum production of the United States over the normal demand is shown by the fact that the 209,556,048 barrels produced in 1910 brought a smaller return—\$127,896,328—than the 183,170,874 barrels in 1909, which was valued at \$128,328,427. The even smaller output in 1908, 178,000,000 barrels, was valued at still more—\$129,079,184. As the production has increased the average price has gone down from more than \$1 a barrel in 1900 to 61 cents in 1910. These repeated great increases in oil production have been due to the successive development of four great petroleum fields farther west than the old productive centers. By 1900 the country had adapted itself to the influx of oil from western Ohio and Indiana; then came in rapid succession the development of the Gulf field in Texas and Louisiana, the Mid-Continent field in Oklahoma and Kansas, and the Illinois field. In the meantime California's production had been increasing so rapidly that it became the dominant feature of 1909 and 1910, outstripping the production of any other state and promising to retain this supremacy in the future. The trade effect of these developments was largely discounted by the small proportion of gasoline and kerosene yielded by the Gulf and California oils and it was only when the superior character of the Mid-Continent oil was recognized that the middle western contributions began to be taken seriously in the general trade. Geographic and technical factors put California petroleum at a disadvantage compared with the eastern supply,

but the great production has compelled such advances in refining methods as to make it reasonably certain that California will in the future yield good refined products, including lubricating and illuminating oils.

THE results of the latest tests on reinforced concrete, conducted in the College of Engineering of the University of Wisconsin, have just been published by the university. In this bulletin suggestions are made as to the most economical mixture of cement, sand and gravel in making the concrete. It also contains data concerning the strength of different forms of reinforced columns. The loads that may be safely used in designing reinforced concrete columns and the strength of columns resting upon small footings are also dealt with, and conclusions given as to the behavior of the latter. The work in this field has been in progress for about ten years at the University of Wisconsin and the bulletin just published supplements one published about three years ago.

UNIVERSITY AND EDUCATIONAL NEWS

THE directors of Bryn Mawr College have formally accepted the bequest of \$750,000, made by the will of Emma Carola Woerishoffer, of New York, who was killed in an automobile accident last summer. The whole sum has been constituted as a permanent endowment fund, to be named the Emma Carola Woerishoffer Endowment Fund. A scholarship has been founded at the college in memory of Miss Anna Hallowell, of Philadelphia, by her family. The interest of the \$2,500 which is given will be used as a scholarship for an undergraduate student each year.

THE sum of \$50,000 has been given to Beloit College by Mrs. Rufus H. Sage, of Chicago, and will be applied to the endowment of the chair of English literature. The total endowment of the college—in active, interest-bearing securities—is now increased to \$1,251,000, aside from the value of the buildings.

THE University of California announces the establishment by Mr. F. M. Smith, of Oakland, California, of a research fellowship for

investigation of certain problems incident to the growth of cities in the San Francisco Bay region. Attention is to be directed especially to questions relating to the development of parks, playgrounds and other community interests demanding particular consideration of space available for growth. The stipend of the fellowship is \$1,000 per annum, and an additional sum of \$500 annually is provided for expenses of the investigation.

BUILDING operations on the new auditorium of the University of Michigan, made possible by Regent Hill's bequest of \$200,000, will soon be under way. The site has been chosen with a view to commanding a convenient approach when the campus extension plans shall have been carried out. The auditorium, with its two galleries, will have a seating capacity of 5,500.

M. GEORGES LEYGUES has given 25,000 francs to the University of Paris for the new Institute of Chemistry.

THE faculty of the College of Arts and Sciences of the University of Maine has made a change in the requirements for the B.A. degree, abolishing the requirement of ten hours in the classical department. Hereafter, neither Latin nor Greek will be required for admission to the college, nor for the B.A. degree. A broad group system has been adopted within which a student, under the advice of his major instructor and with certain restrictions, may elect his own course.

THE board of trustees of the College of the City of New York has authorized the opening of the college courses to mature and properly qualified applicants who do not wish to pursue the full curriculum leading to a degree. In the department of chemistry special courses are offered in analytical, industrial, organic, physical and electrochemistry with opportunities for investigation. Full particulars may be had by addressing Professor Charles Bakerville, College of the City of New York.

ANNOUNCEMENT is made that the formal inauguration of Dr. John Grier Hibben as president of Princeton University will take place early in May. Dr. Hibben will continue to

give his course of lectures on philosophy under the auspices of the Graduate School, and it is expected that he will continue to give at least one course to the undergraduates.

DR. HENRY LOUIS SMITH, president of Davidson College, has been elected president of Washington and Lee University.

MR. H. R. FULTON, associate professor of botany in the Pennsylvania State College, has been elected to the professorship of botany and vegetable pathology in North Carolina College of Agriculture and Mechanical Arts.

BEVERLY W. KUNKLE, now instructor in the Yale Sheffield Scientific School, has been appointed to the chair of zoology at Beloit College to assume his duties in September.

IN Macdonald College, Ste. Anne de Bellevue, Quebec, the following have been appointed to fill the positions named: *Lecturer in Biology*: W. P. Fraser, M.A., Pictou, N. S. *Lecturer in Poultry and Poultry Management*: M. A. Jull, B.S.A., at present Live Stock Commissioner of the Province of British Columbia. *Assistant in Animal Husbandry*: W. J. Reid, B.S.A. *Assistant in Biology*: Peter I. Bryce.

DISCUSSION AND CORRESPONDENCE

"PHENOTYPE" AND "CLONE"

IN calling attention to the frequent misuse of the words "genotype" and "pure line," Jennings says¹ that the word "phenotype" "designates a group of organisms which in outward appearance seem to belong to one type, although in hereditary constitution they may actually differ greatly. *Genotype*, in Johannsen's usage, is not directly contrasted with phenotype," etc.

As I have also used "phenotype" with the meaning indicated by Jennings, I did not recognize the fundamental misconception involved in the quotation given above, when I wrote my note² in response to the article from which this quotation is taken. My attention has been called to this point by Dr. Johannsen, and it seems best to set the matter straight at once, in connection with the at-

tempt made by Jennings and seconded by myself, to restrict to their original meanings, the other terms introduced by Johannsen. "Phenotype" and "genotype," when both are rightly used, are *contrasted terms*, both being *abstractions* referring to the *type* to which an individual or group of individuals belongs, and *not to the group of individuals* belonging to that type. To illustrate the use of "phenotype" in its correct sense, reference may be made to the F_2 of a Mendelian hybrid. When an F_1 hybrid whose genotypic constitution may be represented by the formula, $XXAaBb$, is self-fertilized or crossed with another individual having the same formula, there will be possessed by different individuals among the offspring nine different genotypes, but only four different phenotypes. The nine genotypes may be represented by the formulae: $XXAABB$, $XXAABb$, $XXAaBB$, $XXAabb$, $XXaaBB$, $XXaaBb$, $XXAabb$, $XXaaBb$ and $XXaabb$. The four phenotypes may in similar manner be indicated by the formulae: XAB , XAb , XaB and Xab . As the "phenotype" is the "type of the phenomenon"—the type of that which actually appears—there must always be as many distinguishable groups of individuals as there are phenotypes; hence, the readiness with which the word "phenotype" has been misinterpreted and applied to the group of apparently equal individuals instead of the constitution or assemblage of characteristics with respect to which such a group of individuals is apparently homogeneous.

There is at present no satisfactory word universally applicable to all groups of individuals possessing the same phenotype—the concept for which the word "phenotype" itself has been misused. The words "species" and "sub-species" used by taxonomists are applicable, at least in some cases, to groups of such phenotypically equal individuals, but no one would think at present of applying either of these words to all the numerous slightly differentiated groups which the geneticist is now able to distinguish and with which he is obliged to work. A short and appropriate word for all such groups of individuals,

¹ SCIENCE, December 15, 1911.

² SCIENCE, January 5, 1912.

of whatever degree of differentiation, is greatly needed.

In my discussion of "clone" as a suitable name for any group of plants or animals which has been formed from a single original individual by purely vegetative methods of reproduction, I suggested the restriction of the term to groups of genotypically identical individuals. Further consideration convinces me that this restriction is highly undesirable because it is impracticable. It would be quite impossible to know for a certainty that two twigs used as cuttings or cions from the same tree had the same genotypic constitution, and consequently there could be no security in the assumption that they were members of the same clone, if the definition given in my previous note should be maintained. I wish, therefore, to offer an amendment to that definition by striking out such restriction. The definition may then read: "Clone, a group of individuals traceable through asexual reproductions (including parthenogenesis when unaccompanied by genotypic segregation) to a single ancestral zygote, or else perpetually asexual." This definition puts the word "clone" on exactly the same footing as the expression "pure line," making it a purely genealogical term and involving no implication whatever as to the genotypic equality of the individuals included in the single clone.

GEO. H. SHULL

THE PRIBILOF FUR SEAL HERD

TO THE EDITOR OF SCIENCE: In SCIENCE of October 27, 1911, page 568, there appears an article entitled, "The Pribilof Fur Seal Herd, and the Prospects for its Increase," signed by C. H. Townsend, member of the Advisory Board of the Fur Seal Service.

Dr. Townsend in his article handles rather severely certain persons "whose opinions upon the subject are of little value." I cheerfully admit that I am one of the persons referred to, and I shall be equally frank to say that I am sorry Dr. Townsend feels the way he does, for at the bottom we both desire the same thing, namely, the rehabilitation and preservation of the fur seal herd.

A scientist who desires his opinions upon any subject to be of value must, above all, be accurate as to his facts. In his article Dr. Townsend tells us that "The hook-worm is one of the contributing causes to heavy annual losses among the young seals born on sandy areas."

In view of this statement, I would like to call Dr. Townsend's attention to the report of Walter I. Lembkey, agent in charge of the Alaskan Seal Fisheries, dated December 14, 1906 (page 274), printed as Appendix A to Hearings on House Resolutions No. 73:

Inquiries have been made recently of the Department concerning the present effect of *Uncinaria* on the seal pups, and it has been strongly intimated by certain persons that thousands of pups die annually from the ravages of this parasite, of which no report is made in the agent's report. The fact is that *Uncinaria* has not now, nor has had for several years past, any known existence on the islands. This statement is justified by actual and careful examinations during the last three years.

Also to the report of Harold Heath's "Special Investigation of the Alaska Fur Seal Rookeries, 1910" (same publication as cited above, page 1223):

In earlier times the ravages of the parasitic worm *Uncinaria* were especially noticeable on the Tolstoi sand flat and portions of Zapadni; but in recent years, due to shrinkage of the herd, these areas have been abandoned. Very few cases were noted by Dr. Chichester in 1909, and not one was detected this year. The dead pups dissected were seemingly in a perfectly normal condition, their emaciated appearance and empty alimentary canal indicating death from starvation.

On the question of the closed season Dr. Townsend is especially severe. He tells us that a cessation of slaughtering seals would be "positively dangerous," because of the rapid increase in fighting males. I once made the suggestion to him, favorably received at the time, that as the old bulls haul out on the breeding grounds some ten days in advance of the females, it would be rather a simple matter for the agent in charge and his Indians, armed with a few modern rifles, to dispose of these dangerous surplus bulls. But a far

better answer is found in the fact that years before the club and the gun were used upon the seals the herds thrived and increased, and the more powerful bulls fought their way into the breeding grounds and did their part in creating a strong and virile race that was numbered by millions instead of the few thousands that are left to-day.

The tide of life on the fur islands has reached its lowest ebb. Dr. Townsend himself says that "the stock of females has reached the lowest limit in the history of the Islands." The objectionable persons, of whom I am one, have based their beliefs and opinions not on the conflicting reports of scientists, but on the broad principle that when any species of wild life has become so depleted as to be in danger of extinction, the best remedy is to let it absolutely alone. In this connection I wish to quote President David Starr Jordan, of Stanford University, and also a member of the Advisory Board of the Fur Seal Service:

With men, as with animals, "Like the seed is the harvest." In every vicissitude of race of men or of breed of animals, it is always those who are left who determine what the future shall be.

All progress in whatever direction is conditioned on selective breeding. There is no permanent advance not dependent on advance in the type of parenthood. There is no decline except that arising from breeding from the second-best instead of the best.

The survival of the fittest in the struggle for existence is the primal moving cause of race progress and of race changes. In the red stress of human history, this natural process of selection is sometimes reversed. A reversal of selection is the beginning of degradation. It is degradation itself.

Natural conditions should be the rule, and all killing of selected males for commercial purposes should absolutely cease until the tide of increase in the fur seal herd has once more set toward the flood.

MARSHALL McLEAN,

Member of the Camp Fire Club's Committee on Game Protective Legislation

NEW YORK,
January 2, 1912

QUOTATIONS

THE PRESIDENCY OF THE UNIVERSITY OF MONTANA

For the first time the state board of education permits me, although solely through newspaper reports, to have a statement of considerations which influenced its members in voting "not to renew Dr. Duniway's contract at the close of the year, September 1, 1912."

To the extent that official propriety permits me, and without entering into controversies with my superior officers, I feel obliged to call attention to certain features of this report.

The basis for the action of the state board is said to be primarily a report of the university committee, following an investigation of university affairs made in Missoula on October 22 and 23. It should be borne in mind that this so-called investigation was made without notice to the president of the university, and at a time when he was out of the state. The summing of members of the faculty, of alumni and of students, was prearranged by the chairman of the committee. Under the circumstances there was no opportunity, and there seems to have been no expectation to extend the scope of the inquiry to make it fairly representative of the prevailing opinions and the essential facts which ought to have been considered. Any fair-minded person is entitled to draw his own conclusions concerning such a situation.

It will conduce to clearness if the report of the committee, as published, is briefly considered, point by point. Its essence is found in these statements: First: "We find there is a spirit of unrest and dissatisfaction existing between the student body and the president"; second, "There is dissatisfaction between the alumni and the president"; third, "A lack of cooperation and coordination existing between the president and a large portion of his faculty"; fourth, "We find that the president is exceedingly unpopular among the high school students of the state." A fifth point is added, said to be derived from the general discussion, "That President Duniway does not visit classrooms to ascertain at first-hand the

value of the services of any professor." Perhaps a sixth point should be enumerated to the effect that these other points "seriously retard the growth of the institution and impair the usefulness thereof."

With respect to the allegation that there is a spirit of unrest and dissatisfaction existing between the student body and the president it would be interesting to know just how many and just what students were examined upon this point. As far as such information has come to the president by indirection and rumor, it would appear that a considerable proportion of such students were those who have personal reasons for "dissatisfaction." In the course of administering a clean athletic policy and reasonable standards of scholarship, together with correct principles of conduct, the president has found it necessary to deal more or less sternly with some, at least, whose opinions seem to have impressed the committee. The process that was used to obtain student sentiment is noteworthy, chiefly because of the absence of students whose chief concern is scholarly work or scholarly distinction. To the members of the faculty it has appeared somewhat remarkable that the management of general student affairs in the university has been accompanied with so little friction and with so much genuine good will.

With regard to the second point on the alleged dissatisfaction between the alumni and the president, it is noteworthy that the "request of certain of the alumni" which is said to have produced this investigation was signed by two members of the class of 1911, the other three being undergraduates. One of these graduates had been severely disciplined for various delinquencies, both under the preceding and present administrations. How many alumni, apart from these two, testified is quite unknown to the president. A few persons seemed to be considered "the alumni." It should be added that some of the alumni, like some of the students, have been "dissatisfied" with the president's enforcement of athletic eligibility rules and his neces-

sarily vigorous efforts to prevent professionals from getting places on football teams. A very few also have been displeased because the president declined to perpetuate a so-called honor society, oathbound and secret in character, composed of three members of the faculty and a handful of third and fourth year men. Such an organization was not a healthy influence with regard either to the general student body or to the faculty, whatever may have been its ideals and hopes in its earlier history. A very few also, when they heard of discipline being applied to members of their fraternity chapters, were more or less critical. Certainly a judicious inquiry would consider questions of the animus and credibility of witnesses. Finally, it should be remarked that there has been no expression by "the alumni" of dissatisfaction with the president. On the contrary, many of them have been exceedingly helpful and most cordial in advancing the plans of the president.

With regard to the third point on lack of cooperation between the president and "a large portion of his faculty," it is difficult to see any real justification for such a statement. In an authorized interview published in the *Missoula Sentinel* on October 25 the chairman of the committee is quoted as saying that he "desires to correct the statement published by the *Sentinel* yesterday that any of the faculty had been disloyal to Dr. Duniway." The members of the faculty who were summoned before the university committee voluntarily and individually told the president that they had not been dissatisfied with the administration and that they had so testified to the committee. It would seem that the committee has construed a reasonable amount of candid difference of opinion such as right-minded members of any faculty are sure to feel into "lack of cooperation and coordination." If such a supposition does not fully explain this point is it not reasonable to think that what psychologists call "reaction to external stimuli" might have been produced in a few cases where members of the board let it be known that they were looking for criticism?

Certainly, until October last the president had felt that his relations with the faculty were unusually satisfactory, and he has had very little reason to change his opinion since that time.

The fourth point in the committee's report alleges that the president is exceedingly unpopular among the high school students of the state. Regarding the basis of this charge and the credibility of any testimony to that effect nothing can be said, when nothing is known of the witnesses or their statements. If the truth on this matter is to be ascertained it should be elicited by inquiries from the high schools of the state. It would be most interesting to have high school teachers and their older students, and recent graduates, really express themselves on such a point as this, provided it seems important. The reasons stated by large numbers of the recent freshmen classes of the university when asked to tell why they came to the institution furnished interesting testimony in contradiction of the allegation as made.

It would take too much space to deal adequately with the criticism upon the president for not visiting classrooms. Just a few direct statements may be made. In the first place the board has known, at least since June of 1910, that the president believes any general visiting of university classes by him to be unwise. The board has also known since June of 1910 that the president admits the wisdom of visiting classrooms and laboratories in certain instances and in elementary work. Furthermore the president has visited many laboratories and classes in the university during the last year and a half. An overwhelming majority of college and university presidents do not make a practise of visiting classrooms and declare that such a practise would be unadvisable. Methods that produce good results in the public school system are not applicable to a university faculty composed of highly-trained experts.

It is then declared in general that the president, and his policies, "seriously retard the growth of the university and impair the usefulness thereof." In the face of the growth

of the university in the last two years, one may fairly call this an amazing statement. In December of 1909 the registration of the university for the current term was 145. In December of 1910 the number had risen to 176. In December of 1911 the number had risen to 191. Let it then be remembered that these are the figures for students of university grade, not including a preparatory department, special music students, or any short-course students—classes which swell the total attendance reported for many institutions. If the unpopularity of the president retards the growth of the university is it not interesting that the last two freshmen classes have been the largest in the history of the institution? If this unpopularity causes the university "to lose many students of the state, and is the reason for many of them going east to school when they should go to the university of their own state," is it not interesting that the same problem of migrating students exists in every western state, and that 21 students have entered the university this semester with advanced standing from other colleges or universities?

The whole tone of the university committee's report presents a curious contrast to the language of the following resolution unanimously adopted by the state board of education on June 6, 1911: "We express our commendation and approval of the highly efficient manner in which he has conducted the affairs of the state university, and express our appreciation of the executive and administrative ability shown by him since he has been president of said institution."

An understanding of the procedure of the state board at its December meeting can be reached only by remembering that the sessions of the board, with its presentation of the committee's report, its discussion of the same, and its action upon it, were held and concluded without conference with the president. The president was in Helena at the time, dealt with the university committee on various matters, attended the open sessions of the board, and informed members of the university committee that he would be in immediate

attendance in the capitol building if his presence were desired for the consideration of any matter affecting himself or the university. He was personally assured that nothing of any importance would come up. After the adjournment of the board, certain of its members told him that no action had been taken, and they made similar statements to reporters, who published their declaration in the newspapers.

All of this leads to the inquiry as to what really happened between June 6, 1911, and October last, when certain very important questions which were up for discussion and settlement during that interval must have seriously changed the relations of the president and members of the board. Since the published statement under consideration does not touch upon these subjects, considerations of official reserve preclude more than this allusion to them at this time.

If I may permit myself now to speak in the first person let me conclude by saying that no one can regret more than myself the necessity of discussing educational matters in this way. Since the board has denied to me the usual academic privilege of meeting them face to face for frank discussion and has chosen to say nothing to me except through newspaper reports I am compelled to follow their example. Only the consideration that the people of the state of Montana need to be informed for the protection of higher education, and of their state university in particular, leads me to address the same public before whom the university committee's report has been placed. I hope that the publicity given to these issues may result in nothing but good for higher education in Montana.—C. A. DUNNWAY, in *The Missoulian*.

SCIENTIFIC BOOKS

The Life of the Crustacea. By W. T. CALMAN, Sc.D. New York, The Macmillan Co. 1911. Pp. xiv + 290, with 32 plates and 85 figures in the text.

While the Crustacea have attracted many generations of able students, and while they possess a truly ponderous and rapidly growing

scientific literature, few attempts have been made at a popular exposition. All the more welcome is the work under review, in which the author, a well-known student and writer in this particular field, presents a sketch of the entire class, as a whole. His expressed purpose is to describe in particular the habits and modes of life, as well as "provide for readers unfamiliar with the technicalities of zoology an account of the more important scientific problems suggested by a study of the living animals in relation to their environment."

Excepting alone the insects, the Crustacea are perhaps the most diversified and the most interesting single class of invertebrates. In their multitudinous forms, whether in the seas, the fresh waters, or upon land, they offer a peculiarly attractive field for the study of nearly every problem raised by modern biology, including development, variation, sex, heredity, parasitism and other phases of evolution. The field is both difficult and alluring. We think that Dr. Calman has succeeded admirably in bringing together a host of significant facts bearing upon his subject, and in presenting them in a logical and interesting manner.

A chapter is devoted to the European lobster, considered as an exponent of the class, and following this are sections on Classification and Metamorphosis. Successive chapters (V.-X.) treat of Crustacea of the Seashore, the Deep Sea, Floating Crustacea of the Ocean, Crustacea of Fresh Waters, the Land, as Parasites and Messmates, all loaded with interesting facts and suggestions. A section devoted to "Crustacea in Relation to Man" is less satisfactory. The volume concludes with a review of Fossil Crustacea. The illustrations are both ample and good.

The author speaks from a wide and accurate knowledge of his subject, and such errors as we have noticed are of a minor character. In the superabundance of available materials, every student of this group is bound to find many omissions of matters more or less interesting or important. In the chapter on the lobster a number of statements need to be

revised in order to accord with our present knowledge of this form. We will note the following: The "liver" is now known to be both a digestive and absorbent organ, the finer particles of food being delivered to it directly from the pyloric end of the stomach-sac. The idea that when a "limb is cast off," the opening at the breaking plane becomes closed by a clot of blood, and that further bleeding is thus stopped, had been proved by Emmel to be an error; the stoppage is effected by definite valves, without which the animal would doubtless bleed to death.

A third species of lobster (*Homarus capensis*) is attributed to the Cape of Good Hope. We were under the impression that this shadowy species had never recovered from the aspersions cast upon it by Professor Huxley. Regarding the relation of the young crayfish to its mother (p. 77) many new facts have been brought to light by the studies of Andrews for both *Astacus* and *Cambarus*.

In discussing the phosphorescence of deep-sea crustacea (p. 126) it is noticed that many luminous forms are blind, but that in such cases luminous secretions are emitted from the skin without the aid of specially differentiated organs, the photophores, the complete meaning of which is puzzling, not to say embarrassing, as in certain prawns which illuminate their gill-chambers. We are reminded of a similar trouble regarding the ubiquitous tegumental glands, which occur among other places in the labrum, swimmerets, statocysts, the intestine and the gills. It might be interesting to inquire whether there is any relation between these organs and such parts of the skin as are responsible for the secretions referred to above. In another place it stated that while many deep-sea species are some tint of red, their eggs are blue or green. If these forms were originally emigrants from shallow water, the colors of the eggs would appear to have remained stable notwithstanding the change in the color and habits of the adult, a condition which is paralleled in certain birds like the magpie, wherein the mottled coloring of the egg is evidently older than the habit of covering the nest.

The author suggests that the exceedingly long, attenuated, and often hirsute character of the appendages of deep-sea crustacea may be an adaptation to prevent the animal from sinking in the ooze; we should rather regard such conditions as aids to the animals for feeling their way in the darkness, in other words, as means for increasing their exploratory powers, and for rendering the chemical sense and that of touch more effective.

Regarding the question of metamorphosis among crustacea of the abyss Dr. Calman remarks: "It would seem that, some way or other, the conditions were unfavorable for a free-swimming larval life; but they can not be altogether prohibitive, for many deep-sea crustacea have small eggs, and presumably a metamorphosis." There is certainly no doubt that such species with small eggs undergo a metamorphosis, but it does not follow that the young ascend a mile or more to the surface in order to accomplish it. Such young may pertain exclusively to the hypoplankton and keep near the bottom, or to the mesoplankton in strata not far above it. It would be interesting to know to what extent larvæ like those of lobsters and crabs which keep for a time at least near the surface, and belong to the epiplankton, can adapt themselves to the changes in pressure involved in falling through measured distances in the water. Experiments to settle this point could be made without great difficulty.

The author thus speaks of the various animals which form the floating population of the Sargassum: "All of them are colored olive-green, like the weed among which they live." Now the Sargassum which we have repeatedly encountered in the Gulf Stream in going to or from the West Indies was always a beautiful golden brown tint, flecked with white, the light spots being due to bryozoa which commonly encrust the floats of this plant. Moreover, the entire population—fish (*Pterophryne*), shrimp and a nudibranch mollusk—wore the same colors, and usually in the same simple pattern, brown with oblitterative white spots.

To conclude, in the chapter on the Relation of the Crustacea to Man we miss any adequate account of the valuable lobster fisheries of the old and new worlds, or of the laborious experiments which have been made to rear the young of this much-prized crustacean, and which in America have finally led to success.

FRANCIS H. HERRICK

WESTERN RESERVE UNIVERSITY

Qualitative Chemical Analysis. A Laboratory Guide. By W. W. SCOTT, A.M., chief chemist, Baldwin Locomotive works, formerly Professor of Chemistry, Morningside College, New York. D. Van Nostrand Co. 1910. \$1.50 net.

A Course in Qualitative Chemical Analysis. By CHARLES BASKERVILLE, Ph.D., F.C.S., Professor in the Department of Chemistry of the College of the City of New York, and L. J. CURTMAN, Ph.D., Instructor in the Department of Chemistry of the College of the City of New York. The Macmillan Co. \$1.40 net.

We have in these two books further additions to our already long list of works on qualitative analysis.

The first contains a discussion of the ionic hypothesis, the mass law and other physical chemical principles with their applications to qualitative analysis, followed by a systematic study of the detection and separation of bases and acids, methods of analyzing an unknown substance and tables containing special data. The best methods of separation have been selected and a very valuable addition made in the form of notes on each group. In these notes the reasons for the various reactions used and the precautions recommended are discussed, thus enabling the student to work intelligently and not, as is so often the case, merely mechanically. This book can be recommended as an excellent laboratory guide to qualitative analysis, especially if the principles discussed in the theoretical part are applied to the reactions studied.

In the second work special emphasis is placed on the quantitative discrimination of the substances detected by qualitative meth-

ods of analysis as a preparation for quantitative analysis. In selecting methods of analysis those have been preferably chosen which they think can be most readily used by the student; especially if they give rise to precipitation tests which will enable the student to approximate the amounts present. As in the other work, explanatory notes have been introduced.

An objection the reviewer would make to this book is the almost complete absence of any applications of the present theories of solution and the mass law to the reactions of qualitative analysis. Although the statement is made in the preface that these matters are usually presented in lectures in general chemistry and may be taken up in lectures on qualitative analysis, they do not apply these in this book; but retain the molecular reactions and the theory of the formation of complex compounds in place of the methods which are now so generally taught.

J. E. G.

SPECIAL ARTICLES

CHANGES IN CHEMICAL ENERGY DURING THE DEVELOPMENT OF *FUNDULUS HETEROCILITUS*

ALTHOUGH at present it is hardly possible to do more than give a brief report of progress, nevertheless, the results which have been obtained from the calorimetric study of the beginning and end stages in the development of *Fundulus heteroclitus* harmonize so completely with the results gotten by Tangl and Farkas in the case of the chick and silkworm, respectively, that a brief account of the work appears warrantable at this time.

Omitting many details of technique, the methods employed in this study were as follows: The eggs of *Fundulus*, immediately after artificial fertilization, and the larvæ immediately after hatching, were dried at 40° C. This portion of the work was carried on at the Marine Biological Laboratory at Woods Hole, to whose director, Professor Frank R. Lillie, I am indebted for the use of a room. The material, which had been previously carefully counted, was then preserved in the dry state in ordinary phials until used for the chemical

and calorimetric analyses which were carried out in Budapest.

Determinations of the chemical energy—heat combustion—in known quantities of the material were made by means of the bomb calorimeter, strictly according to the rules of modern calorimetry. Small (practically, between 15° and 25° C.) calories were recorded. Concerning the applicability of thermochemical methods to the study of embryogenesis, nothing need be said at present except that indirectly the work of Rubner and others, while directly that of Tangl and his students, can leave no doubt on this point.

Comparison between the fertilized egg and the hatched embryo of *Fundulus* disclosed a discrepancy in chemical energy which can be in no wise interpreted as an analytical error. Thus briefly summarizing the results, it was found that

	Calories
1,000 fertilized eggs of <i>F. heteroclitus</i> contained	3,264
1,000 hatched larvae of <i>F. heteroclitus</i> contained	2,550
Transformed during development	710

If loss of energy during development is to have any special significance from the standpoint of embryology, it must be shown that no substances rich in chemical energy diffuse out of the egg during the period under discussion. This seems to be true of *Fundulus*, for the nitrogen content of the egg remains constant up to the 240th hour, and probably for the whole developmental period. In the case of the frog also, no substances appear to diffuse out of the egg, for the ash content remains the same from the beginning of the development to the end. The same thing has also been proved for the trout, the chick and the silkworm (Tangl and Farkas). The only alternative therefore seems to be that the discrepancy in chemical energy between the end and beginning stages of development is due to the transformation of chemical energy into heat, or other forms, and not to the diffusion of energy-containing substances out of the egg.

During the developmental period, 384 hours, during which 1,000 eggs of *F. heteroclitus*

lose 710 calories of chemical energy, larvae are produced whose organic substance weighs in the neighborhood of 0.2 gram. If now the amount of energy lost is divided by the amount of organic substance produced and multiplied by ten, $710/200 \times 10$, we get 3.6 large (kilogram) calories—an amount which expresses the specific work of development, namely, the amount of chemical energy transformed during the production of one gram of organic substance of *F. heteroclitus*.

The further discussion of these results, as well as of many subordinate questions connected with them, must be reserved for the future, when I shall report upon work of the same kind now in progress on other forms, but not sufficiently advanced to warrant description. The results of Tangl on the chick, however, and of Farkas on the silkworm are highly suggestive, for the specific work of development (Entwicklungsarbeit) of the dry substance (*i. e.*, organic substance + ash) in the case of the former is 3.8 kilogram calories and of the latter 3.1. In consideration of the fact that the errors of observation and analysis are concentrated on these end figures and embodied in them, the almost complete identity of the results for these widely divergent forms,

<i>Fundulus</i>	3.6 ¹ (organic substance)
Chick	3.8 (dry substance)
Silkworm	3.1 (dry substance)

is a strong argument in favor of Tangl's hypothesis expressed two years ago, namely, that the specific work of development (Entwicklungsarbeit) is not a function of phylogenetic position, but the embryogenetic formation of living substances widely divergent in organization seems to be connected with an equal expenditure of chemical energy.

In conclusion, I wish to acknowledge with

¹ Owing to the presence of sea salts in my material, I am unable at this time to calculate the corresponding value for the dry substance of *Fundulus*. Unless the ash diverges very widely from the expected, however, the specific work of development of 1 gr. of dry substance will be in the neighborhood of the value given for the organic substance.

gratitude my great indebtedness to Professor Francis Tangl, director of the Royal Hungarian Institute for Animal Physiology. The unusual generosity with which he placed at my disposal equipment and experience has alone made possible results which otherwise would have been quite beyond my reach.

OTTO C. GLASER

ROYAL HUNGARIAN INSTITUTE
FOR ANIMAL PHYSIOLOGY,
BUDAPEST, November 20, 1911

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE
SECTION F

MEETINGS of Section F were held on Wednesday, December 27, the forenoon session for the reading of papers and the afternoon in joint session with the American Psychological Association. The following officers of the section were elected:

Vice-president and Chairman for next meeting—Professor William A. Loez.

Member of Council—Professor Edwin Linton.

Member of Sectional Committee for five years—Professor A. M. Reese.

Member of General Committee—Professor T. W. Galloway.

The following abstracts of papers have been received by the secretary of the section:

REESE, ALBERT M.: *Effect of Narcotics upon the Development of Hen's Egg.*

The paper is a preliminary account of the effect of certain reagents (alcohol, ether, chloroform, chlorotone and magnesium chloride) upon the development of the hen's egg. Alcohol was fatal in about 75 per cent. of the experiments; ether in about 35 per cent.; chloroform, chlorotone and magnesium chloride were almost universally fatal, though the fatalities in the last two cases were probably largely due to faulty technic.

LINTON, EDWIN: (1) *The Adult Stage of Dermocystis ctenolabris* Stafford. (2) *Trematode Sporocysts in an Annelid.* (No abstracts of these papers received.)

ROHRER, C. W. G.: *Observations on the Chestnut-worm.*

The chestnut-worm, or grub, is the larval stage of *Balaninus caryatipes*, one of the Curculionidae or nut-weevils. The "worm" winters in the earth, and issues forth in the spring as a small snout-beetle or weevil. A peck of chestnuts may con-

tain as many as 5,838 worms. One chestnut may contain four or even more. The female, in laying eggs, first bores a hole with her snout through the growing chestnut-burr and into the nut. She then drops an egg into this hole, and pushes it to the bottom of the hole with her snout.

REED, H. D.: *The Occurrence of Dermal Poison Glands in the Nematognathi.* (No abstract received.)

SMITH, HUGH M.: *Notice of a Remarkable New Family of Pediculate Fishes.*

Among the fishes collected by the Albatross during the 1907-1910 expedition to the Philippine Islands is a deep-water pediculate from the coast of Celebes, which becomes the type of a new species, genus and family.

ROGERS, BURTON R.: *A New Method of Preserving Anatomical Dissecting Material of Large Animals.* (No abstract received.)

SMITH, MIDDLETON: *The Bowhead.*

Description of the whale; of the primitive implements used in its capture; of the method of killing and "cutting in" as practised by the Eskimo; and of the uses of its products.

CLARK, AUSTIN H.: *A Biological Contribution to the Paleogeography of Australia.*

The old continent of Australia included the present Australia, with New Guinea and the Aru Islands to the north and Tasmania to the south. Timor, Timorlaut, the Ki Islands, Ceram, Gilolo and the islands further west, the islands north of New Guinea, New Britain, New Caledonia, Norfolk Island, New Zealand and the islands further north and east have no relationship whatever with Australia, but form part of more or less marked subdivisions of the East Indian region.

The Australian coast line has subsided since the maturity of the true Australian crinoid fauna; this subsidence has been least on the southeast coast, the degree gradually increasing toward the west and with slightly greater rapidity toward the north; on the west coast there is a similar increase in the degree of submergence from the south to the north. The Australian crinoid fauna of to-day is in the midst of one of those faunal changes called by Cuvier a "cataclysm."

JOHNSON, M. E., and TORREY, H. B.: *Control of Color Differentiation in Frog Tadpoles.*

Experiments have shown that the amount of melanin developed in the skin of frog tadpoles varies with the kind rather than with the quantity of food. Among tadpoles growing at the same

rate, those fed on beef liver produced more melanin than those fed on egg yolk. Egg albumen, beef suet and brown beans resembled beef liver in this respect. These results point directly to the presence of substances in the food that exert a specific influence upon melanin formation. It is well known that tyrosin may be oxidized to melanin in the presence of tyrosinase in various organisms. In the experiments, any possible tyrosinase in the food was inactivated by boiling the latter; and tyrosin was present in excess in the tissues. These facts suggest the presence of an inhibitor in the egg yolk, an idea supported by numerous experiments in glass. Tyrosin + tyrosinase + egg yolk (digested or undigested) produce little or no color, while tyrosin + tyrosinase + beef liver (digested or undigested) together produce a marked reaction. That the inhibiting factor may exist in the fat content of the food (i. e., lecithin, cholesterin) is a possibility now under investigation.

WOODRUFF, L. L.: *Observations on the Origin and Sequence of the Protozoan Fauna of Hay Infusions.*

Data derived from the daily observation, for several months, of the sequence of various types of protozoa in a large number of infusions of hay. Attempt to show that there is a more or less regular sequence. Data also on the source of the protozoa observed in infusion.

MACCUBDY, H. M.: *Observations on the Reactions of Asterias forbesii to Light.*

Specimens from six to twelve centimeters in diameter respond definitely and are negative in their reactions to sunlight. The first visible effect of light is a characteristic ventralward movement of the affected rays or ray, accompanied by a retraction of the tube feet. This reflex takes place in specimens either with or without the eye spots. The so-called eyes are drawn inward and the surrounding spines close more or less closely over them in bright light, and the tips of the exposed rays are held low. These reflexes may be local or general. They tend to inhibit or counteract exploratory movements, retard current impulses and induce physiological states and relations which require readjustment. The direction of the new movements is influenced by the retarding effect of light and is determined by impulses from the central nervous system. The tube feet extend readily in shade, and toward the shaded side of a ray. Light retards extension movements. The same is true for the tube feet of *Cribella sanguinolenta* and *Thyone briarius*. It thus appears

that the tube feet as well as the surface of the rays are sensitive to light. The outcome of the reaction is a succession of events usually though not invariably the result of the checking of some movements and the freedom of others. A movement becoming effective functionally induces co-operation in adjacent parts not in that condition. A contact stimulus is functionally stronger than the light stimulus, but is influenced by the latter.

GUDGER, E. W.: *Oral Gestation in the Gaff-topsail Cat-fish, Felichthys felis.*

How the eggs are extruded, fertilized and transferred is not known, but when these processes are effected the male incubates them in his mouth not only until they are hatched by the bursting of the shell, but until the yolk has been absorbed and the young are able to care for themselves. The largest number of eggs taken from the mouth of one male was 55. A cement cast of his mouth had a volume of 580 c.c. The volume of an average-sized egg is 3.75 c.c., of the 55 eggs 206.3 c.c., add 25 per cent. for interstices; total space occupied by the 55 eggs equals 258 c.c. This fish was 22 inches long, and of average size. The eggs average 19-20 mm. in diameter, and the young fish at the end of the period of incubation are 85-100 mm. long. The length of this period can not be stated definitely, since it has been found to be impossible artificially to carry the eggs and embryos to the stage of the free-swimming young. However, it is about 80 days. During all this time the nurse does not seem to feed. The large eggs would, if spawned on sandy or shelly bottoms, be quickly destroyed by crabs and by other fish; if laid on a mud bottom (where the breeding fish are caught) their considerable weight would cause them to sink into and be smothered by the mud. The habit is common to estuarine cat-fish in all tropical and warm temperate regions. These data are based on five summers' work at the Beaufort laboratory of the United States Bureau of Fisheries, in which time scores of male fish carrying eggs and larvæ have been captured and autopsied.

PARKER, G. H.: *The Nervous and Non-nervous Reactions of Actinians.* (No abstract received.)

MAST, S. O.: (1) *The Behavior of Fireflies and its Bearing on Certain Theories of Tropisms.* (2) *Seventeen Different Definitions of the Term Tropism as Applied to Reactions in Organisms.* (No abstract received.)

ESTERLY, C. O.: *The "Oil Fly" of California, Psilopa petrolei.*

The larvæ live in crude oil in incredible numbers. The eggs seem to be deposited outside the oil and the larvæ enter the oil as soon as they hatch. The maggots float in the oil whether it is of the heaviest or lightest specific gravity. All the crude oils observed are lighter than water, but the larvæ sink in water. Even when the animals are motionless in crude oil, they remain on the surface with only the breathing tube visible. If the larvæ are put into such products of petroleum as distillate or kerosene, or such substances as olive oil, they live for from 24 to 48 hours. They do not float in these fluids and it seems likely that the chemical nature of the substances is not the only unfavorable condition. The maggots swarm about the bodies of animals like moths or caterpillars caught in the oil and doubtless feed on them. Yet if the larvæ are kept in oil taken direct from the pump or in that filtered through asbestos, they seem to do equally as well, even to pupating. It seems unlikely that organic particles could be present in such oil, and it is an interesting problem whether the animals can obtain nutriment directly from petroleum. Pupation takes place very readily in the laboratory. The proportion of pupæ formed from larvæ kept in fresh pumped or filtered oil is as large as that in oil taken from pools around tanks or wells. The adults and larvæ do not seem to be phototropic, yet the pupæ have temporary positive phototropism. The paper included a description of larval movements.

MAURICE A. BIGELOW,
Secretary of Section F

THE AMERICAN PHYSIOLOGICAL SOCIETY

THE twenty-fourth annual meeting was held in Baltimore and Washington, December 26-29, 1911. Two business sessions and five scientific sessions were held in Baltimore. Two of the scientific sessions were joint meetings with the Biochemical and the Pharmaceutical Societies.

An unusual number of papers and demonstrations—in all sixty-seven—were presented and discussed, and the sessions were well attended, eighty-six of the society's one hundred and ninety members being present at the meeting.

At the first session in Baltimore President Meltzer made a brief and appropriate reference to the late Professor H. P. Bowditch, one of the founders of the society, at the conclusion of which the members present arose and remained standing for one minute as a token of respect to the memory of Dr. Bowditch. This was followed by the

reading of a memorial address on Professor Bowditch by W. B. Cannon.

The following papers and demonstrations were presented at the Baltimore sessions:

W. W. Osterhaut: The Effect of Anesthetics on Protoplasmic Permeability.

F. S. Lee and A. M. Guenther: Some of the General Physiological Properties of Diaphragm Muscle.

J. Auer: The Action of the Digitalis Group upon the Heart and its Similarity to Cardiac Anaphylaxis.

P. E. Howe (by invitation) and P. B. Hawk: A Comparison of the Data from Two Fasts Each Exceeding One Hundred Days in Length and made upon the same Subject.

J. Erlanger: Observations on the Physiology of Purkinje Tissue.

W. B. Howell: Antithrombin.

W. J. Meek: Relation of the Liver to Fibrinogen Formation.

Th. Hough: The Influence of Different Degrees of Muscular Activity on the Alveolar Tension of Oxygen and Carbon Dioxide.

Y. Henderson: A Brief Report upon the Pike Peak Expedition.

A. S. Loevenhart: A Contribution to the Theory of the Respiration.

W. T. Porter: The Vaso-motor Nerves of the Heart.

W. T. Porter: Remarks on the Relation of the Phrenic Nerve to the Spinal Respiratory Cells.

T. S. Githens and S. J. Meltzer: The Effect of the Removal of the Heart upon Morphized Frogs. T. Sollmann and P. J. Hanzelick (by invitation): Post-mortem Absorption by the Lymph Vessels.

Y. Henderson: Some New Respiration Apparatus.

W. Salant: A Modified Langendorff Apparatus for Perfusion of Isolated Heart.

G. W. Fitz: A Perfected Model of the Shadow Pupillometer.

W. T. Porter: An Improved Membrane Manometer.

A. J. Carlson: A Method for Studying the Movements and Tonus of the Empty Digestive Tract by the Means of the X-ray.

C. C. Guthrie: Some New Apparatus.

H. Cushing: The Hemodynamic Action of the Cerebrospinal Fluid.

J. R. Murlin and H. C. Bailey: The Urine of Late Pregnancy and the Puerperium.

C. W. Greene: The Storage of Fat in the Sal-

mon Muscle Tissue and its Resorption during the Migration Fast.

H. C. Bradley: Intestinal Absorption.

J. J. R. Macleod: The Relation of the Supra-renal Gland to Sugar Production by the Liver.

V. C. Myers and G. O. Volovic: Metabolism in Experimental Fever with Special Reference to Creatinine Elimination.

T. B. Osborne and Lafayette B. Mendel: The Role of Proteins in Growth.

A. B. Macallum: The Role of Surface Tension in the Distribution of Salts in Living Matter.

L. B. Kleiner and S. J. Meltzer: A Comparison of the Effects of Subcutaneous and Intramuscular Injections of Adrenalin upon the Production of Glycosuria.

H. B. Williams, J. A. Riche and Graham Lusk: The Hourly Chemical and Energy Transformations in the Dog which Follow the Ingestion of Meat.

A. Hunter: The Iodine Content of the Thyroid Glands of Sheep Fed Mainly upon Marine Algae.

E. B. Meigs and L. A. Ryan: The Chemical Constituents of the Ash of Smooth Muscle.

H. Cushing and C. Jacobson: Further Studies on the Relation of the Neurohypophysis to the Assimilation of the Carbohydrates.

D. R. Joseph and S. J. Meltzer: The Effect of Stimulation of the Peripheral End of the Splanchnic Nerves upon the Pupils.

W. E. Garrey: Compression of the Heart Nerves of Limulus and the Mechanisms of Heart "Block."

S. Simpson: Some Problems in Hibernation.

D. E. Jackson: A Note on the Pharmacological Action of Vanadium.

C. Brooks: The Blood Pressure of the Normal Unanesthetized Animal under Various Conditions.

W. B. Cannon: The Effects of Stimulation of the Peripheral End of the Splanchnic Nerves.

S. J. Murlin and J. R. Greer: The Relation of Heart Action to Respiratory Metabolism with Determination of Internal and External Respiratory Quotients.

W. G. MacCallum: Further Studies on the Nature of Tetany.

G. W. Fitz: The Principle of the Shadow Pupilometer.

W. P. Lombard: The Pressure in the Small Blood Vessels of the Skin.

C. J. Wiggers: Respiratory and Cardiac Variations in Pulse Pressures.

A. J. Carlson: The Condition of the Digestive Tract in Parathyroid Tetany.

H. Lussky and A. J. Carlson: Further Studies

of the Aceto Nitrile Test for Thyroid Substance in the Blood.

S. A. Matthews: The Effect of Eck's Fistula on the Formation of Bile (dog).

C. Voegtlin and B. M. Bernheim: Further Studies on the Function of the Liver in Various Metabolic Processes.

A. Woelfel: The Place of Fixation or Reconjugation of the Amino Acids in the Body.

J. A. E. Eyster: Electrocardiogram Studies.

E. D. Brown and T. Sollmann: Effect on Blood Pressure Produced by Traction on the Carotid Artery.

E. M. Ewing and H. C. Jackson: A Study of the First Diastolic Rise (c wave) and First Diastolic Fall (x fall) in the Venous Pulse.

J. G. Wilson and F. H. Pike: A Note on the Relation of the Semi-circular Canals to the Motor System.

W. E. Burge: Separation of Pepsin and Rennin by a New Method.

H. H. Hagan and J. K. Armond: The Relation of Calcium to the Cardioinhibitory Function of the Vagus.

E. B. Meigs: Microscopic Studies of Living Smooth Muscle.

S. Simpson: The Curve of Growth in the Dog.

E. L. Ross and P. B. Hawk: Further Studies on the Effects of Etheranesthesia on Metabolism.

F. S. Lee and M. Levine: The Action of Alcohol and Water on Muscle.

J. Auer and S. J. Meltzer: (1) The Respiratory Effect of Electrical Stimulation of the Central End of the Vagus Nerves in Dogs. (2) Inhibition of Respiration by Distention of the Lungs of Dogs under Intratracheal Insufflation.

C. Brooks: The Action of Sodium Citrate on the Circulation.

C. W. Greene: The Absorption of Fat by the Salmon Stomach.

C. W. Greene and Mr. Skaer: The Absorption of Fat by the Mammalian Stomach. (Preliminary communication.)

H. McGuigan and O. Mostrom: Studies on the Convulsive Reflex Produced by Strychnine, (a) Habit, (b) As Modified by Epinephrine.

W. E. Garrey: Temperature Coefficient of Nerve Cells of the Ganglionated Cord of Limulus Heart.

The program for the joint session with Section K, American Association for the Advancement of Science, in Washington, consisted of a symposium on Acapnia and Shock. Papers were presented by Y. Henderson, W. H. Howell, G. W. Crile, J.

Erlanger and S. J. Meltzer. The general discussion was participated in by W. T. Porter, J. J. R. Macleod, G. W. Crile, A. J. Carlson, G. T. Kemp and Y. Henderson.

The following persons were elected to membership in the society:

Rockefeller Institute—A. E. Cohn, I. S. Kleiner, F. W. Bancroft.

Johns Hopkins University—L. G. Rowntree, G. H. Whipple, W. E. Burge.

University of Pennsylvania—R. M. Pearce, A. I. Ringer.

University of Syracuse—F. P. Knowlton, C. G. Rogers.

Columbia University—H. A. Stewart.

University of Nebraska—A. E. Guenther.

University of Wisconsin—H. C. Bradley.

University of California—T. C. Burnett.

Western Reserve University—P. W. Cabb.

Starling-Ohio Medical School—R. G. Hoskins.

University of Chicago—A. B. Luckhardt.

The relation of the society to the *American Journal of Physiology* continues as in the past, and A. J. Carlson, W. H. Howell, F. S. Lee, G. Lusk, S. J. Meltzer and W. T. Porter were appointed to constitute the editorial committee for the publication of the *Journal* during 1912.

In the past the annual meeting of the society has occupied three days of the convocation week. But owing to the rapidly increasing number of workers in the society the number of papers submitted for the meetings has already become too great for proper presentation and discussion, in spite of the recent organization of the Biochemical and the Pharmacological Societies. It is generally felt that much of the value of these meetings is lost when time is lacking for adequate discussion of the scientific program. At the second business session this question was considered and the following measures in the way of remedy were proposed and discussed:

1. Extending the time of the meeting to four or more days.

2. Meeting in two or more sections according to subjects.

3. Two or more meetings annually—one in the west and one or more in the east.

4. Limiting the number of papers (each member is at present virtually limited to one communication).

5. Dispense with the formal reading of papers, and devote the time to their discussion on the basis of printed abstract.

6. Changing the time of the meeting to May or June.

7. A closer affiliation with the Biochemical and the Pharmacological Societies.

After a prolonged and earnest discussion the question was referred to the council with instructions to report at the next annual meeting, which will be held in Cleveland, Ohio, in December, 1912.

The following officers were elected for the year 1912:

President—S. J. Meltzer, New York.

Secretary—A. J. Carlson, Chicago.

Treasurer—W. B. Cannon, Boston.

Members of the Council—J. Erlanger, St. Louis, and F. S. Lee, New York.

The arrangements effected by the Baltimore members and friends of the society contributed greatly to the success of the meeting. The headquarters of the three societies were located in the same hotel, and practically all the visiting members were housed in this same hotel. The local members had agreed to dispense with private entertainments, and in their place had arranged for all members and visiting friends an informal dinner followed by a smoker on the evenings of December 27 and 28. By this delightful informality the members were kept together and opportunities afforded for social intercourse and informal conferences and discussions. It was generally felt that this feature should be perpetuated in future meetings.

A. J. CARLSON,
Secretary

UNIVERSITY OF CHICAGO,
January, 1912

THE AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS

THE sixth annual meeting of the American Society of Biological Chemists was held in Baltimore and Washington, December 27–29, 1911. The sessions in Baltimore, held in affiliation with the American Physiological Society and the American Society of Pharmacology and Experimental Therapeutics, in the physiological building of the Johns Hopkins Medical School, were well attended, over forty of the members being present.

The single session in Washington, at the McKinley High School, a joint meeting with the Biological Section of the American Chemical Society, was of exceptional interest from the standpoint of the character of the papers presented and the discussions which they elicited. The following

is a list of the communications which were offered at these meetings:

BALTIMORE, WEDNESDAY, DECEMBER 27, 2:00 P.M.

W. R. Blatherwick, C. P. Sherwin and P. B. Hawk: Intestinal Putrefaction and Bacterial Development accompanying Water Drinking and Fasting.

Amos W. Peters: Essential Conditions of Accuracy and Rapidity for the Determination of Sugar by the Methods of Copper Reduction.

S. R. Benedict: Preparation of Creatine and Creatinine from Urine.

S. R. Benedict: Estimation of Creatinine.

H. S. Raper: The Fate of Fat which Enters the Blood Stream.

H. Gideon Wells: Purines and Purine Enzymes of Tumors.

Fletcher McPhedron: Hemolytic Power of Fatty Acids.

P. A. Shaffer: A New Salt of β -Oxybutyric Acid.

Lawrence T. Fairhall and P. B. Hawk: The Allantoin Output of Man after Water Ingestion. The following papers were read by title:

E. B. Hart, E. V. McCollum and H. Steenbeck: Physiological Effects on Growth and Reproduction of Rations Balanced from Restricted Sources.

E. V. McCollum and J. G. Halpin: Synthesis of Lecithins in the Hen.

E. B. Hart and H. Steenbeck: Effect of High Magnesium Intake on Calcium Excretion by Pigs.

E. V. McCollum: Relation between Nitrogen Retention and the Rise of Creatinine Excreted during the Growth of the Pig.

E. V. McCollum: Comparison of the Nutritive Value for Growing Pigs of the Nitrogen from the Oat and Wheat Grains.

E. V. McCollum and E. B. Hart: Experiments on Feeding Dissected Milks.

BALTIMORE, THURSDAY, DECEMBER 28, 9:00 A.M.

(Joint session with the American Physiological Society)

J. R. Murlin and H. C. Bailey: The Urine of Late Pregnancy and the Puerperium.

C. W. Greene: The Storage of Fat in the Salmon Muscle Tissue and its Resorption during the Migration Fast.

H. C. Bradley and H. S. Gasser: Intestinal Absorption.

J. J. R. Macleod: The Relationship of the Suprarenal Glands to Sugar Production by the Liver.

Victor C. Meyers and G. O. Volovie: Metabolism in an Experimental Fever with Special Reference to Creatinine Elimination.

Thomas B. Osborne and Lafayette B. Mendel: The Role of Proteins in Growth.

A. B. Macallum: The Role of Surface Tension in the Distribution of Salts in Living Matter.

I. S. Kleiner and S. J. Meltzer: A Comparison of the Effects of Subcutaneous and Intravenous Injections of Adrenalin upon the Production of Glycosuria.

H. B. Williams, J. A. Riche and Graham Lusk: The Hourly Chemical and Energy Transformations in the Dog which Follow the Ingestion of Meat.

Andrew Hunter and Sutherland Simpson: The Iodine Content of Thyroid Glands of Sheep Fed Mainly upon Marine Algae.

Edward B. Meigs and L. A. Ryan: The Chemical Constituents of the Ash of Smooth Muscle.

BALTIMORE, THURSDAY, DECEMBER 28, 2:00 P.M.

H. H. Bunzel: Measurements of Oxidases.

J. R. Murlin and H. I. Muller: Creatine Elimination in the Pregnant Dog.

J. J. R. Macleod, C. D. Christie and J. D. Donaldson: The Estimation of Dextrose in Blood and Urine by the Difference in Reducing Power before and after Yeast Fermentation.

Torald Sollman (for P. J. Hanzlik): Recovery of Alcohol from Animal Tissues.

Otto Folin and F. F. Flanders: A New Method for the Determination of Hippuric Acid (and Benzoic Acid) in Urine.

H. C. Bradley: Synthetic Action of Enzymes.

Paul E. Howe and P. B. Hawk: A Metabolism Study on a Fasting Man.

Paul E. Howe and P. B. Hawk: Hydrogen Ion Concentration of the Feces.

The following papers were read by title:

H. C. Jackson: Changes in the Composition of Blood and Muscle following Double Nephrectomy and Bilateral Ureteral Ligation.

C. C. Benson: Note on the Inorganic Constituents of Human Blood.

P. A. Levene and W. A. Jacobs: On Sphingosin.

P. A. Levene and G. M. Meyer: On Glycolysis.

P. A. Levene and D. D. Van Slyke: On the Picroates of Glycecoll.

H. C. Bradley: Connective Tissues of *Limulus*.

C. F. Langworthy and R. D. Milner: The Respiration Calorimeter and its Uses for the Study of Problems of Vegetable Physiology.

H. McGuigan and C. L. von Hess: Glycolysis as Modified by Removal of the Pancreas and by the Addition of Antiseptics.

H. McGuigan: On the Excretion of Formaldehyde, Ammonia and Hexamethylenamine.

A. D. Emmett: Effect of the Quantity of Protein Ingested on the Nutrition of Animals. VI. On the Chemical Composition of the Entire Body of Swine.

O. H. Brown: The Effect of Quinine on Pneumococci.

WASHINGTON, FRIDAY, DECEMBER 29, 2:30 P.M.
(Joint session with the Biological Section of the American Chemical Society)

Thomas B. Osborne and Lafayette B. Mendel: Maintenance and Growth.

Wilder D. Bancroft: The Study of Environment.

Treat B. Johnson: Synthesis of Thiotyrosine.

Alfred Daehnowski: The Relation of Vegetation to the Chemical Nature of Peat Soils.

C. L. Alsberg and O. F. Black: Phytochemical Studies on Hydrocyanic Acid.

Andrew Hunter and M. H. Givens: The Nitrogen Excretion of the Monkey with Special Reference to the Metabolism of Purines.

John H. Long: The Definition of Normal Urine.

W. Koch: Should the Term Protagon be Retained?

H. S. Reed and H. S. Stahl: Oxidizing Enzymes in Certain Fungi Pathogenic for Plants.

William J. Gies: Modified Collodion Membranes for Studies of Diffusion.

M. S. Fine: A Method for Differentiating between Metabolic and Residual Food Nitrogen in the Feces.

E. Monroe Bailey: Biochemical and Bacteriological Studies on the Banana.

The following officers were elected for the year 1912:

President—A. B. Macallum.

Vice-president—Graham Lusk.

Secretary—A. N. Richards.

Treasurer—Walter Jones.

Additional Members of Council—H. P. Armsby, Lafayette B. Mendel, H. Gideon Wells.

Nominating Committee—John J. Abel, F. G. Benedict, H. C. Bradley, Otto Folin, Wm. J. Gies, Andrew Hunter, J. B. Leathes, J. J. R. Macleod, D. D. Van Slyke.

A special committee, consisting of W. Koch (chairman), H. D. Dakin, William J. Gies, J. B. Leathes and Jacques Loeb, was appointed for the

purpose of considering and reporting to the society concerning the nomenclature of the lipoids.

Resolutions were passed by the society concerning the recent deaths of three of its members, Dr. Raymond H. Pond, Dr. Arthur H. Koelker and Professor William F. Koelker.

A. N. RICHARDS,
Secretary

THE MEETINGS OF THE ECONOMIC AND SOCIOLOGICAL SOCIETIES AT WASHINGTON

SEVEN societies met at Washington during the holidays to discuss economic and sociological problems. These societies represent the various fields of economics, civics, home economics, labor, sociology and statistics. Acting under the rule of the council of the American Association for the Advancement of Science adopted at Minneapolis, Section I, devoted to economics and social science, yielded the regular program to the visiting societies with the exception of two sessions, provided by the management governing the correlation of the sections to visiting societies.

One of the notable features of the convocation was the address of Senator Burton, the retiring vice-president of Section I, delivered at a joint session of the American Civic Alliance and of the section at which Dr. J. Pease Norton presided. The address of Senator Burton on the "Causes of the High Prices" has been printed in full in SCIENCE. Senator Burton presented an analysis of the causes which have operated to increase prices and showed conclusively that in addition to the vast increase in the gold supply many individual causes have been operative. The American Economic Association adopted a resolution in favor of an International Commission on the Cost of Living to study the remedies. This was the subject of a round table discussion led by Professor Fisher. Senator Burton's opinion was that natural causes would in a short time produce relief.

At this session the section adopted this resolution:

"Resolved: That the chairman be empowered to appoint a committee whose power and duty shall be to take such steps as shall in its opinion be most effective in focusing the attention of the proper persons and institutions upon the problems of soil erosion and the improved utilization of land through tree crops. This committee to report at the next meeting of the association."

Other addresses were delivered at this meeting

on "Review and Outlook for Banking Reform" as follows:

1. "Requirements of the South in Banking Reform," by William A. Blair, vice-president of the People's National Bank, Winston-Salem, N. C.

2. "The Function of a Gold Reserve in a National Banking System," by Hon. George E. Roberts, Director of the Mint, Washington, D. C.

3. "Relation of Banking Reform to Corporate Financing," by Mr. J. Selwyn Tait, late manager of the International Banking Corporation's Branch, Washington, D. C.

4. "The United States Treasury as Related to the Country's Banking System," by the Hon. Lee McClung, Treasurer of the United States.

5. General discussion of foregoing papers, by Roger W. Babson, formerly expert for the Monetary Commission, Wellesley Hills, Mass.

The Friday evening session of the section, to which the members of the American Economic Association and those of the American Civic Alliance were invited, was one of the largest meetings of the series. Some seven hundred persons listened to addresses on "Corporate Problems of To-day." Dr. John Franklin Crowell, associate editor of the *Wall Street Journal*, was in the chair and opened the session with a brief address. Six speakers summarized the corporate problems of banking and currency, of the railroads and of the industries. The program was:

1. "Problems of Banking and Currency," (a) by the Hon. A. Piatt Andrew, assistant secretary of the Treasury, Washington, D. C.; (b) by the Hon. James T. McCleary, secretary of the American Iron and Steel Institute, New York City.

2. "Problems of Industrial Corporations," (a) by Professor T. N. Carver, of Harvard University, secretary of the American Economic Association; (b) by Hon. John Hays Hammond, Washington, D. C., late special ambassador of the United States to Great Britain.

3. "Problems of Railway Corporations," (a) by John B. Daish, Esq., counselor-at-law, Washington, D. C.; (b) by Samuel Untermeyer, Esq., counselor-at-law, New York City.

Each paper presented in succinct form the essential limitations of the problems. If the six addresses were printed together, an excellent handbook of the corporate problems of to-day would be furnished for students of this field.

Much interest was aroused by the address of Mr. John Hays Hammond, relating to the Industrial Corporations, in which he advocated a federal commission. At the close of the meeting, Dr.

Crowell announced the election of Mr. John Hays Hammond to the vice-presidency of the section, succeeding Dr. J. Pease Norton.

Smaller meetings and round table gatherings were held by the visiting societies. The Home Economics Society presented a large and varied program.

The American Economic Association discussed immigration, economic concepts, tariff investigations and the decline of rural population in the south. In the session on tariff legislation Professor H. Parker Willis took issue with Professor Henry C. Emery in regard to the principles underlying the investigations of the Tariff Board and the result was an illuminating discussion fruitful of results.

Dr. John L. Coulter, of the University of Minnesota, and Dr. Frissell, principal of Hampton Institute, spoke on "Rural Conditions in the South."

An important symposium of the American Civic Alliance on the subject of "Old Age Retirement" was participated in by several speakers. Mr. Miles Dawson, actuary of the Armstrong Commission, discussed retirement plans in foreign countries and showed the necessity of the straight pension plan. In this opinion Mr. Dawson was seconded by Mr. M. F. O'Donoghue, president of the United States Civic Service Retirement Association, representing a quarter of a million government employees. An opposite view was taken by Congressman Gillette, who advocated that a portion of each employee's salary or wages be reserved by the government for the use of the employee after his retirement, this fund to be free from attachment and alienation. This plan, sometimes called the "Compulsory Savings Plan," was put forward as the remedy for the situation developed by the large number of superannuated employees in the civil service.

Interesting sessions were held by the statisticians. "The Naturalization of Immigrants" from a statistical standpoint was presented by Mr. Fred C. Croxton, statistician of the U. S. Immigration Commission. Other sessions were devoted to the "Forecasting of Business Conditions by a Study of Statistics" and "Industrial Injuries." The former was treated by Mr. Roger W. Babson, economic engineer, of Wellesley Hills, Mass., and by Dr. John F. Crowell, of the *Wall Street Journal*. The latter was discussed in a joint session of the Statisticians and the American Association for Labor Legislation, led by Charles P. Neill, Commissioner U. S. Bureau of Labor; Frederick L. Hoffman, president of the Statistical

Association; Mr. David Van Shaack, of the Aetna Life Insurance Company, and others. The Association for Labor Legislation also held an important meeting on Friday afternoon on "The Unemployment Problem in America." Secretary Nagel presided.

The only criticism that could be made is that there were too many important meetings held at substantially the same time, so that it was impossible to attend them all. The general result was that one attended that meeting wherein his own personal interest lay, and thus lost the opportunity of hearing and knowing about other subjects, which frequently throw a side light previously unnoticed on one's own ideas and viewpoint.

SEYMOUR C. LOOMIS

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

At the meeting of the American Philosophical Society, at Philadelphia, on January 5, 1912, Professor D. W. Johnson, of Harvard University, presented a paper on "The Physical History of the Grand Canyon District."

Few points of geological interest appeal so strongly to the public as the Grand Canyon of the Colorado River. Both in the Canyon itself and in the adjacent plateaus, the geological structure most profoundly affects the scenery. The scenic features may be best appreciated if we know the succession of events in the physical history of the region which are responsible for the present surface forms. This succession was made clear by means of a series of diagrams representing various stages in the development of the district. It was shown that the ancient crystallines of the Granite Gorge, the inclined beds of the Algonkian wedge, and the horizontal strata of the Plateau series, as well as the great erosion surfaces which separate these groups of rocks, have all played a part in determining the character of the Canyon scenery; while the Plateau scenery has been profoundly affected by the north-south folds and fractures, vulcanism and long-continued erosion periods. This relation of geology to topography was shown by colored lantern views of the principal features of the district. On the basis of these views a more detailed analysis of certain events in the geologic history was presented.

THE BOTANICAL SOCIETY OF WASHINGTON

The 77th regular meeting of the society was held at the Cosmos Club, Tuesday, January 9,

1912, at eight o'clock P.M. President W. A. Orton presided. Twenty-six members and ten guests were present. E. O. Wootton and F. D. Farrel were admitted to membership.

The following papers were read:

Botanical Gardens of the East: LYSSTER H. DEWEY.

The author made a trip to Java to attend the International Fiber Congress and Exhibition held at Soerabaya in July, 1911, and visited *en route* the botanical gardens in Gibraltar, Algiers, Penang, Singapore, Buitenzorg, Hongkong and Taihoku, Taiwan (Formosa). After describing these gardens in detail the author stated that they are fulfilling a many-sided mission in attracting tourists, educating even the casual observer as to the identity of plants, indicating the sources of plant products, introducing and distributing plants of economic value and affording research workers exceptional opportunities for study.

Fermentation of Cellulose: K. F. KELLERMAN, I. G. MCBETH and F. M. SCALES. (Presented by Mr. Kellerman.)

In the formation and maintenance of humus in agricultural soils the fermentation of cellulose is probably of fundamental importance, yet our knowledge of this question is inadequate. Omeliansky's generally accepted conclusions that cellulose is destroyed only under anaerobic conditions and gives rise either to hydrogen or to methane are erroneous.

Two species of cellulose-destroying and five species of contaminating bacteria were isolated from a culture of Omeliansky's hydrogen organism, and one cellulose-destroying and two contaminating forms from his methane culture; none of the three fermenting species showed any resemblance to Omeliansky's hydrogen or methane ferments. In addition to the species isolated from Omeliansky's cultures eleven other species have been isolated from various other sources; one isolated from manure belongs to the thermophile group.

Contrary to Omeliansky's observation that cellulose-destroying bacteria do not grow upon solid media, most of the species isolated were found to grow readily upon such media as beef agar, gelatin, starch and potato. Some are facultatively anaerobic, but none are strictly anaerobic.

It is usually supposed that filamentous fungi are of little importance in agricultural soils; these investigations show them to be at least as impor-

tant as bacteria in destroying cellulose. About seventy-five species of molds have been isolated, representing a large number of genera; species of *Penicillium*, *Aspergillus* and *Fusarium* are perhaps most numerous.

In the destruction of pure cellulose, either by bacteria or molds in synthetic media, the associative action of organisms which presumably have no cellulose-dissolving enzymes frequently stimulates the growth of the cellulose organism and increases its destructive power.

Some Phases of Microscopical Detection of Decomposition in Food Products: B. J. HOWARD.

W. W. STOCKBERGER,
Corresponding Secretary

THE TORREY BOTANICAL CLUB

THE meeting of November 14, 1911, was held at the American Museum of Natural History at 8:15 P.M., Vice-president Barnhart presiding. Forty-five persons were present.

The minutes of the meetings of October 10 and October 25 were read and approved.

Mrs. N. C. Nuris, 611 W. 177th St., New York City, and Dr. George F. Bovard, University of Southern California, Los Angeles, Cal., were proposed for membership. There being no further business to consider, Mrs. N. C. Nuris was then elected to membership in the club.

The announced scientific program of the evening consisted of a lecture on "Trees of New York City," by Professor C. C. Curtis. The lecture was illustrated by numerous lantern slides.

B. O. DODGE,
Secretary

THE meeting of November 29, 1911, was held in the laboratory of the New York Botanical Garden and was called to order at 3:40 P.M. by the acting secretary in the absence of other officers. The reading of minutes and the transaction of business were passed over and the meeting proceeded with the scientific program. The first announced paper was by Mr. Arlow Burdette Stout on "The Characteristics of the Fungus *Sclerotium rhizodes*, with special reference to its Action on the Cells of its Host," of which the following is an abstract:

Mr. A. B. Stout presented in part the results of his investigations of the fungus *Sclerotium rhizodes* Auersw., a complete report of which will soon appear in a research bulletin of the Wisconsin Agricultural Experiment Station.¹

Special mention was made of the behavior of the fungus in the different organs of the host plant and microscopical preparations were exhibited demonstrating the relations of the fungus to the cells of its principal host *Calamagrostis canadensis*.

The fungus is coexistent in leaves, buds, stems, rhizomes and roots of the infected plants. Filaments of the fungus also form a thin web on the exterior of the roots and extend out into the soil.

In the leaves the fungus is vigorously parasitic. In the culms fungal filaments are most abundant in the region of the nodes, but there is almost no destruction of tissues. In the underground parts of the culms, and in rhizomes the hyphae completely digest the cell contents of cortical cells, but have no effect on the cell walls except at the points of actual penetration. In the older portions of roots the hyphae are scattered through the cortex, where they occupy empty cells. In the younger lateral roots the filaments of the fungus are found penetrating living cells and exhibiting characteristics which have been ascribed to mycorrhizal fungi. Ultimately, however, the cell contents disappear while the fungus remains intact.

The fungus is perennial in the soil, and in the underground portions of the host. It is present in buds, but is unable to penetrate into the growing apex.

The fungus, therefore, exhibits a varying degree of parasitism in the different parts of the host.

The presentation of the second announced paper, "Studies on the Growth and Reproduction of certain Species of *Ascobolus*," by Mr. Bernard O. Dodge, was omitted on account of the illness and absence of Mr. Dodge.

Mrs. N. L. Britton exhibited drawings and microscopic preparations illustrating certain types of thickening in the cell walls of the leaves of mosses.

Dr. N. L. Britton discussed the characters of a new species of *Eleagia* from Cuba. This is a Rubiaceae shrub 8 or 10 feet high, with fruit imperfectly known. The hitherto known species of the genus *Eleagia* occur in the Andes of South America and this new plant from the mountains of Cuba forms another link in the chain of relationship between the flora of the higher altitudes of the West Indies and that of the mountains of South America.

MARSHALL A. HOWE,
Secretary pro tem.

¹ A more complete abstract than is here given appeared in *Phytopathology*, I., 69.

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THE MEASURE OF A SINGER¹

THE historian of the future will probably characterize the period upon which we are now entering in psychology as the period of the rise of the applied psychological sciences. It may, therefore, be meet and proper to take some fundamental concept of applied psychology as topic for this annual address. I select for this purpose the rôle of mental measurement—the possibility, the scope and the meaning of mental measurements as the foundation of applied mental sciences.

In order to illustrate the scope and significance of mental measurement in a concrete and specific instance, I shall make bold to present a psychological outline of the measurement of an individual as a singer. Let us make the assumption that this individual is a girl, fifteen years of age, who has had musical training and now desires the best obtainable advice from a consulting psychologist in music in regard to her future prospects as a singer.

Musical power is generally admitted to embrace certain well-recognized and fairly concrete capacities. In our commonplace judgment about ourselves and others we say: "I have no ear for music." "I can not tell a chord from a discord." "I can not keep time." "I have no sense of rhythm." "I can not tell a two-step from a waltz." "I can not remember music." "I can not image sounds." "I am not moved by music." "I do not enjoy music." Or, if speaking of some one who has musical ability, we say: "He has a

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¹ The annual address before the American Psychological Association, Washington, D. C., December, 1911.

deep rich voice." "He never forgets an air." "He lives in song." Such judgments have reference to generally admitted specific factors involved in musical capacity by virtue of a musical organization. Corresponding to these judgments of native capacity we have judgments about musical education, about musical environment, about special influences and stimuli for the development of musical talent, and about technique and success in the rendition of music. When judgments of this kind are based upon measurements, classified, and adequately interpreted, they may constitute a measure of the individual as a singer.

Unfortunately, we have not the command of an expert in the psychology of music, and the field before us is practically unworked. The illustration will, therefore, be merely a tentative suggestion to blaze the trail a little way.

The measure of a singer should consist of a relatively small number of representative measurements upon specific capacities and achievements. These measurements must be set in a full survey by systematic observation and other verified information bearing upon the valuation of the individual as a singer.

The classification of the measurements must be based upon (1) the attributes of sound which constitute the objective aspect of music, and (2) upon fundamental and essential processes in the singer's appreciation and expression of music.

From the point of view of the objective sound, we must take into account pitch (with its complexes of timbre and harmony), intensity and duration.² From the point of view of mental processes, we may group the tests under the heads, sensory,

motor, associational, and affective, each of these furnishing natural subdivisions. The measurements may thus be arranged in the following program, which should also be the outline for a systematic description.

LIST OF MEASUREMENTS ON A SINGER

I. Sensory.

A. Pitch.

1. Discrimination at a' , 435 vd.
2. Survey of register of discrimination.
3. Tonal range, (a) upper, (b) lower.
4. Timbre—discrimination.
5. Consonance and dissonance.

B. Intensity.

1. Sensibility.
2. Discrimination.
- C. Time discrimination for short intervals.

II. Motor.

A. Pitch.

1. Striking a tone.
2. Varying a tone.
3. Singing intervals.
4. Sustaining a tone.
5. Registers.
6. Timbre: (a) purity; (b) richness; (c) mellowness; (d) clearness; (e) flexibility.
7. Plasticity: curves of learning.

B. Intensity.

1. Natural strength and volume of voice.
2. Voluntary control.

C. Time.

1. Motor ability.
2. Transition and attack.
3. Singing in time.
4. Singing in rhythm.

III. Associational.

A. Imagery.

1. Type.
2. Rôle of auditory and motor image.

B. Memory.

1. Memory span.
2. Retention.
3. Redintegration.

C. Ideation.

1. Association type and musical content.
2. Musical grasp.
3. Creative imagination.
4. Plasticity: curves of learning.

IV. Affective.

- A. Likes and dislikes: character of musical appeal.

²Localization of the tone is irrelevant and the spatial attribute of volume may for the present purpose be considered with intensity.

1. Pitch, timbre and harmony.
 2. Intensity and volume.
 3. Time and rhythm.
- B. Reaction to musical effect.
C. Power of interpretation in singing.

The object of the sensory measurements is to determine to what extent the individual is psycho-physically capable of hearing music. For pitch appreciation, we may measure the discrimination, making sure that we reach the physiological as opposed to the cognitive limit of the perception of difference.³ A rapid survey at about twelve selected points within the range of pitch from 25 vd. to 2,500 vd. will suffice to ascertain if there are any gaps or any other peculiarities in the auditory sensibility to pitch within the range of tones which may be heard as musical. If any peculiarity is found, it may be surveyed in detail. To measure the tonal range of the ear, we determine the upper and the lower limit of sensibility to tone. The upper limit is, however, by far the most variable and important as a factor in musical hearing. The two ears may differ materially in range.

The perception of timbre may be measured by the ability to distinguish a pure tone from a series of artificially built-up clangs.⁴ The ability to analyze clangs

³ The cognitive limit is the limit set by lack of knowledge or training; the physiological is the limit beyond which one can not improve.

⁴ We suffer great confusion at the present time in regard to the use of the term, "quality" of tones. Psychologically, pitch is the quality of the tone, but in physics, oratory, music, and untechnical language, "quality" is used in the sense of timbre, tone-color, or character of the clang. Psychologically, the word, "timbre," alone should be used in this sense. It is timbre which distinguishes the tones of different instruments, the tenor from the bass when singing the same note, or the vowels of our speech. In each of these cases there is only a difference in the number of overtones and their relative dominance, for the tone is ordinarily a clang built up by the combination of a number of

varies with training, and should only be used as a measure of acquired efficiency or skill, although the capacity for such skill is determined mainly by the natural sensory capacity for perception of difference in timbre.

While the perception of consonance and dissonance depends largely upon training, there are fixed limitations in the natural sensory capacity which limit the possibility for appreciating the agreeableness or disagreeableness of combinations of tones. This ability may be measured by determining the ability of the singer in arranging a series of pairs of tones in the order of their consonance.

For the attribute of intensity, we should have at least two sensory measures: (1) the threshold of sensibility to tones in each ear; and (2) the discrimination for variations in the strength of a familiar, relatively pure, musical tone. These measures will show the natural capacity of the individual for the hearing of faint tones, the hearing of intensity accent, and the hearing of shadings in the strength and volume of tones in musical expression. The perception of volume is so intimately dependent upon the perception of strength of tone, that a separate measure is not needed.

While the perception of time is largely associational, we depend ultimately upon the sensory capacity for the perception of short durations and rhythmic effects. Rhythm may be expressed through both time and intensity. For a single measure of the perception of rhythm as a time element, we may eliminate intensity and measure the least perceptible deviation in the duration of the recurrent sound, uniform in all respects except duration. This, taken

partials or overtones, each having a pitch of its own. Timbre may therefore be regarded as a pitch complex.

together with the measure of intensity-discrimination, should correlate well with the measure of the perception of intensity in rhythm-accent.

In the survey of the motor capacity of the singer, we naturally follow the same divisions, according to the attributes of tones, as in the sensory; namely, pitch, intensity and duration of tones. There are four fundamental phases of simple pitch singing which should be examined separately: (1) simple ability to reproduce the pitch of a tone heard one second before the singing; (2) the ability to make faint shadings (sharp and flat) in pitch, (3) the ability to sing intervals, and (4) the ability to sustain a tone, both with reference to periodic and progressive changes in pitch. The record of the ability to sound the pitch of the tone should be taken at c' , 256 vd., and at points near the upper and the lower limits of the musical register of the voice. The voluntary control of the pitch of the voice, measured in terms of the minimal producible, sharp or flat, should all be recorded at the same three points in the register. The measure of ability in singing intervals should be taken (*a*) for two or three relatively pure intervals near the middle of the register of the voice, (*b*) for the singing of the natural scale, and (*c*) for the singing of the chromatic scale. The ability in the sustaining of the pitch of a tone for ten seconds may also be measured at the three representative levels of the register and should be so recorded as to show both progressive and periodic changes. Progressive changes are tendencies to gradually sharp or flat: periodic changes may be either regular or irregular oscillations in pitch, or a general lack of control.

The register of the voice should be stated in terms of the characteristic changes in timbre which take place near the upper

and the lower limits. Thus we may determine the range for agreeable musical tones, for tones easily sung, for chest tones and for true pitch singing. This series of records should be supplemented by a systematic description of the progressive change in the character of the tone from one end of the register to the other.

Under the head of timbre of the voice, the psychological-esthetic effect we seek to establish is the degree of beauty of the objective tone. We therefore eliminate subjective and circumstantial conditions and accessory features of the singing which may modify the agreeableness and disagreeableness of the given tone and consider only beauty as it is objective in the physical tone. This may be measured with considerable precision in terms of the form of the sound wave. From a single, well-chosen, graphic record of the voice, we may work out the following factors: (*a*) purity, the degree of approach to the smooth sine curve in the form of the wave; (*b*) richness, the number of overtones present; (*c*) mellowness, the character of the distribution of the overtones; (*d*) clearness, the uniformity in the form of a series of waves; (*e*) flexibility, the character of the progressive transition from one wave form to another. These purely objective measures of the beauty of the tone must be supplemented by systematic observations on the agreeableness of the timbre of the voice by experts judging separately each of the specific qualitative aspects of the voice as naturally used in singing. Objective record must also be made on the mode of tone production, especially characteristics of the resonance.

The plasticity of the individual in a given capacity is measured by the rate and character of the learning processes in that capacity. We now know enough about the characteristics of learning curves to be able

to determine in a relatively small number of trials the character of the prospect that an individual may have for acquiring skill in any given activity. The plasticity may be measured in this way for any of the motor processes of musical training. If but a single measure of plasticity is to be made, this may well be on the training in accuracy of transition from one note to another, involving the elements of release and attack.

As regards intensity of tone production, we are interested in the natural strength and volume of the tone and in the voluntary control of these factors. The strength of tone is expressed in terms of amplitude of vibration and should be measured in representative parts of the register. In so far as they differ from strength, carrying power and volume may be judged essentially in terms of the mode of tone production. Voluntary control of the strength of tone may also be measured in terms of the amplitude of the vibration. The measurement of voluntary control in the making of fine differences in volume, or in the change of volume as distinct from intensity of tone, is too complicated for our present purpose, but systematic observation of this in ordinary singing is essential.

Motor ability may be measured in terms of the degree of accuracy in the rapid enunciation of a selected list of syllables. The form of the attack is also an excellent measure of time-efficiency in musical action. But the most important of all time measurements is of course the ability to sing in accurate time and rhythm. For time alone, we test the singing of equal durations without accent. For rhythm, in the true sense, the singing must be with time and intensity variables together as in ordinary singing. The measure should be made for both simple and complex rhythm.⁵

⁵ In measurements of motor ability, and rhythm in actual singing, the dictograph or some similar

A number of tests may be grouped under the general head of association, and these may be subdivided somewhat arbitrarily as in the outlined list. We should first secure a quantitative picture of the relative vividness of images from the different senses. Then the auditory image should be tested for fidelity, stability and relevance, in such a way as to reflect the rôle and power of auditory imagery in singing. The same may also be done for motor imagery.

The most fundamental fact about memory is the memory span for musical tones. This may be measured in terms of the number of tones (taken from a single octave, but not forming a known melody) the individual can remember for immediate reproduction or recognition. The power of retention may be measured by determining roughly the extent to which the singer can recall music heard a day or a week before. The power of musical redintegration may be tested by observing to what extent the individual can recall, in their true setting, the fine details of a complex musical production. Here the phonograph can be used to good advantage.

Association type may be given as the name for the sampling of the mental content and the prevailing mode of reaction as determined by free association experiments in what is now called psychoanalysis. This will show, for example, whether the individual lives in music objectively or if the music is to him merely a series of affective stimuli which arouse a feeling of idealized beauty. Most of the relevant facts which may be determined objectively by such diagnostic association tests may, however, be obtained by the expert through direct and unaided observation.

To the musical mind the sounds group themselves in large units, such as themes, movements, phrases, etc. The power of instrument may be used to excellent advantage.

grasp for musical complexes may be measured in terms of a graded series of complexes of musical units, taking in turn the various factors of pitch (including timbre and harmony), intensity and time.

A record of creative imagination may be obtained under experimental conditions by allowing the singer to improvise a tune for a selected stanza. The words of a series of stanzas should convey different types of emotional value. The ability may then be measured in terms of the merit of such a composition as preserved in the dictograph. Here the greatest freedom should be allowed the singer for spontaneous expression.

As knowledge of ability in learning music is essential, the mode of forming, and the natural ability for acquiring, new musical associations should be measured for one or more phases of vocal training, such as the placing of the voice, singing the chromatic intervals, or the analysis of clangs. If a single representative measure were to be made, this might profitably be the establishment of the learning curve for the singing of the untempered chromatic scale.

The affective phase of music is never isolated from the cognitive and motor elements, for both of these always involve some feeling. In such measurements as those of consonance, association type and creative imagination, we deal with facts which are quite as relevant to the affective as to the cognitive side of consciousness. The same principle applies also to some of the motor examples. The musical emotions are conditioned upon the various powers of appreciation and expression which we have just reviewed. Unless our singer has capacity for hearing or expressing a given musical effect, she can not experience emotional pleasure over it. The sensory, motor and associational measure-

ments have therefore determined the presence or absence of capacity for affective or emotional appreciation and expression. There are, however, three general surveys which are of a positive and fundamental nature; namely, musical preferences, reaction to musical effects and power of interpretation in singing.

One affective aspect of the character of the musical appreciation may be determined by working out the curve of likes and dislikes for representative series of musical selections. These should be so arranged as to represent the main types of musical appeal through each of the attributes of sound. Here the measurement may be standardized by having the graded selections furnished in a series of the best quality of phonograph discs. Three series might be used: (1) Pitch, timbre and harmony series; (2) the intensity and volume series; and (3) the time or rhythm series.

The amount and character of reaction to different musical effects may be observed under experimental conditions when the observer is not aware that this is being done; thus, a systematic record of such observations may be made under the guise of repeating the preceding measurement (IV., A, 1) in which the observer works by the method of impression just outlined. The curve for different kinds of mental and physical reactions observed may be made to parallel and supplement the curves for agreeableness and disagreeableness.

There are two aspects to the power of interpretation of music in singing; namely, the appreciation and the expression. Since expression involves appreciation, measurement on appreciation may be omitted. The power of expression may be measured by methods now in vogue for the measuring of merit. Musical experts may be obtained to make comparisons of one

specific element after another in singing under experimental conditions.

As a supplement to these measurements, there must be other measurements, statistical data, biographical information, and free observations regarding musical training, traits of temperament and attitude, spontaneous tendencies in the pursuit of music, general education and non-musical accomplishments, social circumstances and physique.

With this tentative plan of procedure before us as a concrete thing to consider, let us ask and answer the following three questions: How do these measurements acquire unity in meaning? Do they constitute an adequate measure of the singer? Of what practical significance can they be?

With reference to the first of these questions, it can readily be seen that a group of measurements like this is merely a group of samples of measurement. Their unity in meaning depends upon the degree to which they are adequately representative, and are interpreted in true perspective. They are meaningful only when compared with previously established norms, which show the mode and extent of distribution for a sufficiently large number of cases, and are interpreted in the light of the meaning ascribed to each level in the distribution. Take, for illustration, discriminative action in voluntary control of the pitch of the voice in singing. Reference to our norms shows, for example, that a record of .9 vd. means that this ability is within 3 per cent. of the best record for individuals under similar conditions, and that those who have such control are thoroughly qualified to render a high class of music in this respect; while a record of 9 vd. falls within 8 per cent. of the poorest ability measured, and is characteristic of an individual who can not sing; whereas 3 vd. represents the average ability of an untrained individual.

These norms must be worked out with much labor and skill in the interest of an avowedly applied psychology, and must be considered as problems in themselves before any measurements can be of service. During the last year or two a group of research men in the Iowa laboratory have been engaged in working out eight such norms in the psychology of music. After extensive preliminary development of methods and measuring instruments, they have aimed to secure records on two hundred individuals, constituting a homogeneous group for each norm. These norms are: pitch discrimination, vividness of tone imagery, span of tone memory, consonance and dissonance, rhythmic action, intensity discrimination, voluntary control of the pitch of the voice, and the singing of intervals. This is no simple undertaking, and so far the work can only be said to be preliminary. It requires the development of technique for each case, and the measurement must be taken for as many conditions as it is desired to vary under control.

This technique can not be mechanized so that every music teacher can handle it. Even after means and methods have been invented and standardized and norms have been established, it requires an expert, trained in the technique and skilled in the art. This is a field for the consulting psychologist in music, a person who devotes himself to this kind of work professionally. He must not only be able to determine the relative rank of a record by reference to the normal chart, but he must also be able to interpret the meaning of this rank in the light of the construction which has been placed upon the norm. He must be not only a technician, but an artist with appreciation for music, full of ingenuity, sympathetic and incisive in his interpretation. Like the so-called mind reader, he must have at his command a

large repertory of procedures, and be skilled in gathering information from all sorts of expected and unexpected sources during the experimental control. In this art he progressively simplifies procedure, divests himself of mechanical contrivances wherever possible, and takes the singer under more and more natural conditions.

The expert in mental measurement always remembers that the human individual is a psycho-physical organism. He must have records for the physical as well as the mental, and especially for their relationships; and he must interpret each fact, physical or mental, as a feature of an organism, bearing in mind that there is organization in the mental, just as truly as in the physical. With a clear grasp, on the one hand, of the fundamental attributes of objective music, and, on the other hand, of the fundamental capacities of the human organism for appreciating and rendering music, he must select that group of measurements which will answer his purpose: it may be a problem of learning; it may be an attempt to trace the nature of a discovered fault; it may be the proving-up of progress made under a given mode of training. Our present schedule of measurements is merely a sort of relief map for first orientation. The unity of the whole, or of any section, of such measurements lies in the effectiveness with which they serve one purpose.

In this work, systematic observation and description is supplemented by the concrete objective measurements. One of the main purposes of measurement is to secure experimental control of conditions in which systematic observation of factors under control may be recorded, though not a part of the numerical record.

Instead of neglecting what can be known by "common sense," as is often charged, the expert starts with this at its best, grad-

ually culls and sifts his facts in systematic observation, and finally clinches a few of the representative features in objective measurements. The charge that the so-called "practical man" knows more through direct impression, or common sense, than the expert can discover scientifically is a flagrant expression of ignorance. The effect of the scientific point of view is not to belittle the magnitude of music or man. But, as the astronomer sees more in the starry heavens than does the average man on a moonlight stroll, so the expert beholds in music and in the human individual vastly more than the so-called "ordinary man," in this case the mere musician, observes; for his vision is closer, more detailed, more keenly discriminating, recordable, repeatable and more penetrating.

In the Gibson girl we see a most realistic representation of form, face, hand, heart and mind. No stroke by itself has any meaning; no feature is really drawn; no mental faculty is actually represented in the cold, black lines. Yet, of a few rough strokes, the master mind has made such an *ensemble* that we have a true picture of beauty in the expression of physical and mental life. Just so our master of mental measurements will bring together facts, which in themselves may seem meaningless, into an *ensemble*, which adequately represents the individual singer, or some feature of her, for our purpose.

Turning to the second question, as to whether such a measure can be said in any sense to be adequate, let us take an illustration. A man has a richly varied and well-cultivated garden. He is an horticulturist and cultivates the garden for scientific observation, pleasure and table use. Now what would constitute an adequate measure of that garden? It is possible to determine to a high degree of accuracy the

exact size, form and weight of every living plant, the rate of growth of each and every leaf, root, flower and fruit, the absorption rate for each and every chemical element drawn from the soil, the rate of increase in tensile strength, the deposit of chlorophyll, the internal structure of each and every cell, etc., *ad infinitum*. The possibility of measurement is here practically unlimited. An adequate measure is, however, not a complete measure, but one which answers a purpose. The gardener measures the specific thing which he wants to know.

Now, the human psycho-physical organism is at least as rich and as varied as a well-cultivated garden, if we may make so crude a comparison. While mental measurements are not developed to the same degree of precision as those of the gardener, they are nevertheless possible and may be quite as serviceable. The question is not how many measures are possible. No sane individual would ever undertake to make all possible measurements on a singer. The question is this: Can we command measurements which shall answer our present purpose? In the present case, do these measurements give us an adequate estimate of the various capacities and qualifications of this individual as a singer? The list here given is therefore not an attempt to show how many can be made, but to suggest which of those available may answer our purpose, and, when taken together, prove an adequate measure.

In the way of mental measurements, we can get practically what we want, provided we are willing to deal with specific facts. Our present list makes a formidable array, yet it is limited to those for which I, though not an expert in this field, know methods and means of measurement, and to such as are essential to a reasonably representative survey of the matters to which

they pertain; and measurements which would result if any given point were followed up intensively are not mentioned. To the extent that they are representative and no essential feature is overlooked, they constitute an adequate measure of an individual as a singer.

There is a continual warfare between psychology, as a science, and the demands in practical life for a single general measure for some practical purpose. Much work has been done on the naïve assumption that a single measure of a cognitive capacity should serve as a general measure of intelligence. Space discrimination, reaction after choice, the memory span, and such specific cognitive measures have been used in seeking correlations with some sort of generally recognized intelligence, but of course in vain. For psychology demands that each measurement shall deal with something specific and fairly homogeneous, and the record pertains only to the factor under control. Our gardener's measure of the quality of tomatoes may or may not represent a quality of his potatoes, peas or roses. Each article must be measured by itself. So, only when we have collected a sufficient number of data to feel that all the essential and fundamental traits of intelligence are represented, can we speak of an adequate measure of intelligence. The same principle applies to the measure of musical ability.

Turning to the third question, as to the significance of a measure of a singer, we note that, if it is adequate, it places at the disposal of those who can profit by it a classified invoice of useful facts about this singer in such a way that it may be of direct value. The advice based upon such an invoice should be weighed by the expert, the facts should be laid before the teacher, and the pupil should realize that she has become objectified to herself in

such a way that she knows herself with reference to her possibilities as a singer better than she could possibly have learned in any other way. Her future career as a singer may be determined by this and like knowledge which may be gained from time to time. It is doing for her what an invoice does for the banker before he makes a large investment. If her case is promising the record is most stimulating and encouraging. If there is insuperable cause for failure, it may in a very true sense save life by preventing its wreckage upon the stage after long wasted effort. The record shows whether she is by nature endowed with the mind and body of a natural singer, and to what extent for each item; and it points out to her the high places and the low places in her capacities and possibilities. It substitutes procedure with knowledge, for the haphazard procedure which has always been followed in music.

In giving and taking advice of this sort we must, however, not forget the enormous resourcefulness of the human will, and the possession of latent powers. A one-legged man may become a rope dancer, a blind man a guide, a man with wretched voice an orator. Furthermore, art is possible only where there is willingness to overlook faults. A singer may be permanently lacking in some fundamental capacity and yet have such merits in other respects, or have such exceptional ability in covering, that she may be successful in spite of an overt handicap. But even then psychology has warned and explained.

This invoice also serves to explain experience of the past which may not have been understood. If the singer has had defeat, it will show exactly why. If she has been misguided in musical training, it may show the nature of the error and its results. If the singer is conscious of lack in some capacity, the record shows the na-

ture of this lack and may even suggest a remedy, if such there be. Even among the best musicians it is rare to find some one who does not have some type of difficulty. Indeed, the difficulties of the singer are notoriously great. If psychological measurement can lend a hand through the laying bare of the condition of the difficulty and by determining its nature and extent, as well as by discovering those who may not be aware of their genuine ability, it will indeed be in this respect a handmaid of music.

Another effect of such measurements is not only to objectify the elements of musical appreciation and expression in such a way as to deepen insight in the expert, the teacher and the pupil; but it will also be reflected in the science and art of music as the scientific conceptions become generally known. The measurements will furnish a sort of skeleton for the psychology of music.

From the very nature of his art, the musician, as a rule, takes the same kind of attitude toward his performance as an author of high national reputation took to the Ouija board, which I had the pleasure of observing in action. In a certain sitting where the Ouija board was being shown, I remarked upon the extraordinary quickness of the sitter's eye in reading the spelled words. "Eye," he said. "Do you think I use my eyes?" "Let us try it. Close your eyes and proceed." Just as he started, I slid the board an inch to the side, and of course the rider did not hit a letter correctly. The performer was completely astonished. He had engaged in more than one hundred and fifty successful sittings, and yet he had not become aware of the fact that the use of his eyes was essential to his success. The message had come to him as a communication from without. The demand for so-called inspiration in

music develops this attitude. The musician proceeds with a remarkable unconsciousness of the elements involved both in the appreciating and performing of music. Any musician who is invited into the psychological laboratory where experiments in the psychology of music are performed, will demonstrate this, which is an entirely natural fact and casts no reflection upon him. The psychology of music for musicians has not yet come into existence. Its coming depends upon the recognition psychologists will give to the possibility of psychological measurements in music. The musician waits for the psychologist to blaze the trail. He is a most docile inquirer when opportunity is given. The perspective of music, and the perspective of the musician, which is gained by the objectifying of factors involved, will be projected into our common account of music, and this will vitalize musical ideas and furnish the singer a more general insight into his capacities and possibilities.

Such features of the psychology of music will form a foundation for musical pedagogy. Last year the director of a great symphony orchestra brought his instrumental and vocal soloists into the psychological laboratory and there performed a large number of experiments on them. Everything proved practically new to these musicians and yet they did not tire in pointing out what a great help each and every measurement would be in their training if they were available. Take one example—the measurement of the pitch of an instrumental or vocal tone as seen in direct reading on an instrument in the laboratory. Orchestra leaders and soloists continually differ in regard to the pitch sung or played under given circumstances. The director called up the players of the oboe, the French horn and the first violin, in turn, and the instant each played, the re-

cording instrument showed, to a small fraction of a vibration, how much the tone played varied from the true tone, and disputes of long standing were settled in a moment. The conductor then proceeded in the same way with his vocal soloists. They all saw their faults and fortes pictured quantitatively on the instrument, and left the laboratory unanimous in the verdict that the introduction of such psychological measurements into the conservatory would be a great step in the advancement of musical instruction.

It is the business of the psychological laboratory to develop measuring instruments and methods, and to standardize them because, when the musician employs any of these measurements, he is employing psychological, and not musical, technique.

Measurements of this sort may be divided into four groups according as they represent essentially natural capacity, plasticity (that is, capacity for learning), acquired skill, and knowledge; and, in each and all of these phases, the art of music would profit by such facts.

After all, pure psychology will be the chief gainer. One can not observe under controlled conditions in a field so rich and unworked without gathering new facts, correcting errors, broadening views and deepening insight into the nature of the mental processes involved in music. Applied psychology of music is to pure psychology of music as engineering is to physics; they must go hand in hand. Neither stands higher nor lower than the other in the rank of merit as a pursuit. And especially at the beginning of such an applied science as psychology, too high a value can not be placed upon the matter of laying solid theoretical foundations before we begin to work for practical results.

In conclusion, then, what is the lesson of

our illustration? The message I have attempted to convey may be stated in the following propositions:

1. Technical psychology may be so employed as to furnish qualitative and quantitative classified knowledge about a singer.

The question as to the nature of mental measurement does not enter into this discussion. That question has had its day. I am using the term measurement in the accepted sense in which we use it every day in the psychological laboratory, taking for granted that there is general agreement in regard to its nature and its limitations. The selection has been made on the theory that measurements of the kind we commonly accept in psychology may be so employed as to furnish a serviceable invoice of the natural capacity, plasticity, skill and knowledge a particular individual may have for doing a particular thing.

2. This more or less exact knowledge may be so gathered as to serve immediate and direct practical purposes. We have inconsistent demands for applied psychology from the various arts, professions and sciences. Our illustration shows how one such demand may possibly be met. The effect of such an illustration should be to awaken confidence in our method, to awaken a wholesome respect for actual facts, and to ward off superficial and hasty promises of results.

3. Applied psychology, if such there is to be, must be experimental in method and spirit. It is the introduction of the principle of measurement that has given us a science of pure psychology; and there will be no science of applied psychology until the same principle is believed in and acted upon seriously by those who would make its applications. This does not imply a narrow insistence upon experiments everywhere, but rather a whole-hearted accept-

ance of the spirit of experimental method.

4. There is need of consulting psychologists, trained in pure psychology and in the work to which it is to be applied, who shall devote themselves professionally to applied psychology. The field of the psychology of music is promising.

5. This attitude of modern psychology toward the human individual and the art of music will lead to a keener and more penetrating insight into the nature and the conditions of both the individual and his art, and this will result in helpful guidance and a more vital appreciation and respect for the wondrous possibilities of the singer and the song.

6. We must not entertain the idea that applied psychology is to live merely upon the crumbs that fall from the table of pure psychology, nor that it can be reduced to a set of ready-made rules which may be handed down to the uninitiated. Applied psychology "must recognize itself, its diversities, its stupendous difficulties, its essential limitations and withal its promise and worth."⁶

CARL E. SEASHORE

UNIVERSITY OF IOWA

THE AMERICAN SCHOOL HYGIENE ASSOCIATION

THE next meeting of the American School Hygiene Association is scheduled to occur in Boston, March 28, 29 and 30, probably at the Harvard Medical School. The following is a partial program for the meeting: Demonstrations of ventilating systems, school nursing, medical inspection, out-of-door schools and school furnishings in certain public and private schools of Boston; reports of committees on "Ventilation," and on "Standardization of School Books"; papers by Dr. Ernest B. Hoag, lecturer on hygiene, University of California; Willard S. Small, principal, Eastern High School, Washington, D. C.;

⁶ Seashore, "The Consulting Psychologist," *The Popular Science Monthly*, March, 1911, p. 290.

Henry H. Goddard, director of research in the Training School for Backward and Feeble-Minded Children, Vineland, N. J.; Guy Montrose Whipple, Cornell School of Education; Dr. G. S. C. Badger, Boston, Mass.; David Snedden, Massachusetts Commissioner of Education; Dr. Thomas D. Wood, Teachers College, New York City; L. N. Hines, superintendent of schools, Crawfordsville, Ind.; William H. Burnham, professor of pedagogy and school hygiene, Clark University; Dr. Leonard P. Ayres, Russell Sage Foundation; David Spence Hill, Tulane University; Miss Alice L. Griffith, San Francisco; "Hygiene of Swimming Pools in Schools and Universities," Dr. M. P. Ravenel, director, Wisconsin State Hygiene Laboratory; "The Deaf Child," Dr. Helen MacMurchy, Toronto; "Contagious Skin Diseases in Relation to Schools," Dr. C. J. White, Boston; "Defects in the School Curriculum in Physical Training shown by the Disabilities of College Students," Dr. Dudley A. Sargent, Harvard University; "Health Problems encountered in Home Visits to School Children," Dr. A. E. Shipley, Brooklyn, N. Y.; "The Mentally Defective Child," Dr. Isabel Thompson Smart, New York City; "Recent Tests of Heating and Ventilating Apparatus in Public Schools," Frank I. Cooper, Boston; "The Hygiene of the Ear," Dr. C. J. Blake, Harvard Medical School; "Ventilation," Dr. Luther H. Gulick, director, department of child hygiene, Russell Sage Foundation; "The Hygiene of the Nose and Throat," Dr. E. A. Crockett, Boston; "The Importance of School Hygiene from the School Committee Standpoint," Joseph Lee, president, Playground Association of America; "Applications of Hygiene in a Preparatory School for Boys," Dr. Elias G. Brown, director, the Mountain School for Boys, Allaben, N. Y.; "Scoliosis in Relation to School Life," Dr. Robert W. Lovett, Harvard Medical School; "Venereal Contagious Diseases in Children as affecting School Conditions," Dr. W. P. Lucas, Harvard Medical School; "Sewage Disposal in Rural Schools," Dr. J. N. Hurty, state commissioner of

health, Indiana; "School Room Air and Its Relation to Disease," Dr. M. J. Rosenau, Harvard Medical School, and "Oral Hygiene," by Dr. W. H. Potter, Harvard Dental School.

THE ROCKEFELLER FOUNDATION

MR. JOHN D. ROCKEFELLER has consented to a modification of his plan for the establishment of the Rockefeller Foundation under federal auspices in deference to criticism in congress and from other sources.

The modified bill has been introduced in the senate and house. The changes in the scheme are: (1) Congress to retain the right to impose such limitations on the objects of the corporation as public interest may demand. (2) The total amount of property to be held by the Foundation is limited to \$100,000,000. (3) The income of the corporation is not to be added to the principal. (4) The foundation may wind up its affairs in fifty years, or congress may do so after a century has passed. (5) Instead of being a self-perpetuating corporation, its new members are to be chosen subject to the veto of an outside body.

SCIENTIFIC NOTES AND NEWS

DR. GEORGE JARVIS BRUSH, emeritus professor of geology in the Sheffield Scientific School of Yale University, eminent for his contributions to the science of mineralogy, died on February 6, aged eighty years.

It is proposed to have painted and to present to the American Philosophical Society a portrait of its president, Dr. William W. Keen, who, on January 19, celebrated his seventy-fifth birthday.

DR. CHARLES E. MUNROE, professor of chemistry and dean of the Faculty of Graduate Studies at George Washington University, who has completed his fortieth anniversary as an academic investigator, educator and administrator, will be given a banquet at the Cosmos Club, Washington, on the evening of February 23.

THE American Museum of Safety has presented its gold medal to Dr. Alvah H. Doty for progress and achievement in the promotion of hygiene and sanitation and the mitigation of occupational diseases.

M. LOUIS GENTIL has been elected president of the French Geological Society.

THE Geological Society of London will this year award its medals and funds as follows: Wollaston medal, to Mr. Lazarus Fletcher, F.R.S.; Murchison medal, to Professor Louis Dollo; Lyell medal, to Mr. Philip Lake; Wollaston fund, to Mr. C. I. Gardiner; Murchison fund, to Dr. Arthur Morley Davies; Lyell fund, to Dr. A. R. Derryhouse and Mr. R. H. Rastall.

At a recent meeting of the Rumford Committee of the American Academy of Arts and Sciences, a grant of \$250 in addition to former appropriations was made to Professor A. L. Clark, of the Kingston School of Mining, in aid of his research on the physical properties of vapors in the neighborhood of the critical point.

DR. FREDERICK CHEEVER SHATTUCK has resigned the Jackson professorship of clinical medicine at Harvard Medical School, which he has held for the past twenty-four years. Dr. Shattuck will become professor emeritus on September 1, 1912.

DR. C. RAUNKJÄR has been appointed professor of botany and director of the botanical garden at Copenhagen in succession to Professor Eugene Warming, who retires from active service.

SIDNEY L. GALPIN, instructor in mineralogy, Cornell University, has been appointed assistant state geologist of Georgia, to succeed Otto Veatch, who accepts a position with the U. S. Bureau of Soils.

MR. A. C. VEATCH, having returned from a year's examinations and explorations in the Trinidad and Venezuela oil fields, and having resigned from the U. S. Geological Survey, where he was geologist and chairman of the land classification board, will practise as a consulting geologist.

DR. MAX UHLE has resigned the directorship of the Museo de Historia Nacional at Lima, Peru, and accepted the offer of the Chilean government to take charge of its archeological research, with headquarters at Santiago.

DR. GEORGE BRUCE HALSTED'S "Rational Geometry," has been translated into the French language by M. Paul Barbarian and published by Gauthier-Villars. The book has also been translated into German and Japanese.

PROFESSOR WM. PATTEN, of Dartmouth College, and Mrs. Patten sailed from San Francisco on January 24 for Honolulu, Fiji, Auckland and Sydney. His book on "The Origin of Vertebrates," of which he has just finished the proofreading, will soon be published by P. Blakiston's Sons, Philadelphia.

PROFESSOR ALEXANDER SMITH, head of the chemistry department of Columbia University, lectured before a joint meeting of the Syracuse Chapter of Sigma Xi and the Syracuse Section of the American Chemical Society on the evening of January 19, on "Some Essentials in the Teaching of Chemistry which are often neglected."

DR. WALDEMAR KOCH, assistant professor of pharmacology in the University of Chicago, known for his important researches in the chemistry of lecithin and of the brain, and on the quantitative study of animal tissue, died of pneumonia on February 2, aged thirty-six years. Dr. Koch was the nephew of Robert Koch.

MR. CHARLES FINNEY COX, treasurer of the New York Academy of Sciences and of the New York Botanical Garden, past-president of the academy and the author of contributions on botanical and zoological histology and the theory of evolution, has died at the age of sixty-six years.

CHARLES GILBERT WHEELER, assistant state geologist of Missouri from 1859 to 1861, professor of chemistry in the old University of Chicago, from 1868 to 1889, since then consulting mining geologist and mining expert, died on January 30 in Chicago, at the age of seventy-five years.

DR. SOPHIA JEX-BLAKE, who was responsible for the foundation of schools of medicine for women in London and Edinburgh, and practised medicine for many years in Edinburgh, has died at the age of seventy-two years.

UNIVERSITY AND EDUCATIONAL NEWS

CONDITIONAL gifts of \$100,000 to Washington and Jefferson College at Washington, Pa., toward a \$500,000 fund, and \$50,000 to the Emory and Henry College at Emory, Va., toward a \$250,000 fund, were voted at a meeting of the General Education Board of the Rockefeller Foundation on January 26. Frederick T. Gates was reelected chairman and Wallace Buttrick, secretary of the board for 1912. These two officers and Robert C. Ogden, Walter H. Page, John D. Rockefeller, Jr., Starr J. Murphy and Edgar L. Marston form the executive committee. Jerome D. Greene, business manager of the Rockefeller Institute for Medical Research, was elected a member of the board.

CORNELL UNIVERSITY again has a forestry faculty. One year ago Mr. Walter Mulford, junior professor of forestry in the University of Michigan, was appointed professor of forestry at Cornell, and has been in Ithaca since last summer. This fall Mr. John Bentley, Jr., formerly of the U. S. Forest Service, was appointed assistant professor in the department. And now Professor Filibert Roth, who for the past nine years has been at the head of the forest school at the University of Michigan, has accepted appointment at Cornell as professor of forestry and head of the department. The forestry work is a department of the New York State College of Agriculture at Cornell University. The department plans to give a thorough professional course.

DR. HUGH P. BAKER, professor of forestry at Pennsylvania State College, has been appointed to fill the newly created post of professor of forestry at the University of Illinois.

MR. A. W. NOLAN, of West Virginia University, has been appointed assistant professor of agriculture. Dr. B. E. Powell, formerly private secretary to President James, has been appointed journalist in the College of Agriculture and Experiment Station.

DR. J. B. WOODWORTH has been promoted to an associate professorship of geology at Harvard University.

PROFESSOR W. A. BONE, F.R.S., Leeds University, has been appointed professor of fuel and refractory materials in a new department of applied chemistry now being established in the Imperial College at South Kensington, London.

PROFESSOR HESS, of Würzburg, has received a call as director of the eye clinic of the University of Berlin.

DISCUSSION AND CORRESPONDENCE

FORMATION OF CLOUDS OVER FIRES

TO THE EDITOR OF SCIENCE: In your issues of May 15, 1908, and October 23, 1908, there appeared letters describing the formation of clouds observed above the column of smoke from large fires. In the latter letter, by Wm. F. Wallis, no mention of the character of the clouds thus formed is given; I am under the impression that Mr. B. M. Varney, in his letter of May 15, described these clouds as cumulus clouds, but as I have not that number of SCIENCE before me can not now be sure that he did so describe them. If previously noted occurrences of clouds over fires have been of cumulus clouds, it may be of interest to note a formation of a slightly different type.

On the morning of November 16, 1911, the revolutionary forces attacked the city of Foochow, and set fire to the Manchu quarter of the city. The fire burned more or less fiercely for some twenty-four hours. About 1:05 p.m. on the 9th, when the air temperature was 70°, the relative humidity 52 per cent., and the sky otherwise cloudless, there appeared at the top of the smoke column rising from the city a white cloud closely resembling the fracto-cumulus. The cloud maintained its position over the column of smoke for only a very few minutes, and then melted away, but was followed some fifteen minutes later by a similar cloud, which soon disappeared. How frequently and at what intervals this formation and disappearance occurred I do not know, but several times later until about 4:30 p.m. similar clouds were observed for a few minutes. These clouds were at about the average height of cumulus clouds, and would seem to have been formed, as Mr. Varney suggests, by

the draft carrying water vapor (in not very large quantities in this case) upwards to a level of cloud formation.

WALTER N. LACY

FOOCHOW, CHINA,
November 11, 1911

ENDOCRYPTA HUNTSMANI

TO THE EDITOR OF SCIENCE: My attention has been called to the fact that the generic name "*Crypta*," used on page 19, in my paper on "The Hydroids of the West Coast of North America," published May 13, 1911, as a bulletin from the Laboratories of Natural History of the State University of Iowa, had previously been applied to another genus. I shall change it, therefore, to "*Endocrypta*," a name that I believe has not been used, and one that is equally significant. The new species described should, therefore, appear as *Endocrypta huntsmani*.

C. MCLEAN FRASER

SCIENTIFIC BOOKS

The House Fly—Disease-carrier. An account of its dangerous activities and of the means of destroying it. By L. O. HOWARD, Ph.D. New York, Frederick A. Stokes Company, Publishers. Pp. xx and 1-312; 40 figs. and 1 colored plate.

I am glad Dr. Howard starts his little book with a colored plate illustrating his subject, because it is a good one and because it explains, if we study it carefully, why, when we look at the fly with a good even if low-powered lens, it looks like a pretty combination of soft velvety browns and tans, while if you look at it with the unaided eye you see only a uniform pale gray. There are other, most excellent figures of the house fly, his various parts and stages in the book, a few of them original, most of them from good modern sources, and altogether the book is well and practically illustrated throughout, to the very last sanitary privy.

There is no doubt but that Dr. Howard knows his subject and no doubt either that he who reads it will learn much concerning the fly problem: he will marvel, however, at how

much we already know, at how much work has been done throughout the world and at how much is yet unknown and remains to be done.

Dr. Howard gives us the systematic position, the structure and the general development of the house fly, or, as he frequently drops into saying, the typhoid fly, and on these points he speaks with authority and from personal knowledge. In working over in detail the habits of the various stages he brings together the literature of the subject from practically all over the world and makes a very readable account of it indeed. It shows that the house fly has long attracted attention, everywhere.

In dealing with the adult stage, the function of the insect as a disease-carrier comes in for careful consideration and this part of the book is at once the most interesting and valuable. Dr. Howard is fully convinced of the culpability of his culprit, and he marshals the evidence against him in absolutely convincing form. I doubt whether it is possible to read this series of chapters or sections showing the connection between the various germ diseases and their transmission by fly agency without feeling that a genuine conservatism had animated the writer in his investigation. Antagonistic evidence is brought out and explained and a full bibliography of the subject is given.

It is surprising to find that the house fly has no considerable number of natural enemies capable of keeping it in check and that one of our most promising methods of control rests upon a partially unverified statement concerning the insect's life history.

By the lay reader those sections dealing with the practical handling of the pest will have the most careful scrutiny and these sections have been most carefully written. Dr. Howard has not only had personal experience with practical work in Washington; but has probably seen and conferred with every man who has had a real campaign to carry out. He is therefore very conservative in his suggestions and points out difficulties as well as successes. He also points out that actual number of flies alone, no matter how disgusting, is not always indicative of the presence of

disease and he furnishes abundant suggestions upon which intelligent fly campaigns may be based when the local conditions rendering them necessary are fully understood.

JOHN B. SMITH

NEW BRUNSWICK, N. J.,
January 17, 1912

Die Palaeobotanische Literatur. By W. J. JONGMANS. Zweiter Band—Die Erscheinungen des Jahres 1909 und Nachträge für 1908.

In the issue of SCIENCE for August 26, 1910, the writer published an account of the initial volume of Jongman's "Paleobotanical Bibliography," which covered the year 1908. The second volume of this laborious undertaking has just been distributed. It is from the press of Gustav Fischer, of Jena, and aims to include all of the contributions to paleobotanical literature that were published during 1909. Additions for 1908 that were omitted in the first volume are included and all of the species described or mentioned in the discussions, together with the geological horizons, are arranged alphabetically, and this, the main part of the work, is preceded by a list of the contributions numbered chronologically and arranged by authors.

The present volume makes a book of 417 pages, or about twice the size of volume one, and fully maintains the high standard of the latter. It is indispensable to the working paleobotanist. Botanists, geologists and bibliographers also owe Dr. Jongmans a debt of gratitude.

Individuals and institutions can cooperate in the continuation of this valuable work by sending their publications promptly to the author in care of the Royal Herbarium at Leiden, Holland.

EDWARD W. BERRY

SCIENTIFIC JOURNALS AND ARTICLES

In the *Philippine Journal of Science*, Section D, No. 4, Dean C. Worcester describes newly discovered breeding places of Philippine sea birds, illustrated with half-tone plates which show great numbers of boobies and

terns which are apparently without any fear of the photographer. The same author also notes a probable hybridism among boobies. R. C. McGregor reports the capture of *Puffinus chlororhynchus* Gould off the coast of Luzon, and describes a new species of noddy tern, *Micranous worcesteri*, from Cavilli Island in the Sulu Sea. R. W. Shufeldt's article on the skeleton in the flying lemurs is concluded. A. S. Pearse presents notes on the habits of *Thalassina anomala* (Herbst), and concerning the development of frog tadpoles in sea water. Section B, No. 4, contains two papers on amœbæ found in the Philippine Islands. In one Ernest Linwood Walker makes a comparative study of the amœbæ in the Manila water supply, in the intestinal tract of healthy persons, and in amœbic dysentery and shows that all hitherto cultivated amœbæ are non-pathogenic, but that the true pathogenic amœba can not be cultivated; in the other Andrew Watson Sellards discusses immunity reactions with amœbæ. Weston P. Chamberlain presents a statistical study of typhoid fever in the Philippine Islands; a map shows the distribution of typhoid fever in the Islands. Horace D. Bloombergh presents data relative to the Wassermann reaction in syphilis, leprosy and yaws. In Section A, No. 4, Alvin J. Cox discusses Philippine soils and some of the factors which influence them, the chief among these being the division of the Philippine Islands into regions because of types of rainfall. Raf. A. Herrmann presents a theory on the formation of the central Luzon plain. Benjamin T. Brooks describes essential oil from *Michelia champaca* L. and discusses its chemical constitution. He also gives a study of a number of other new Philippine essential oils and reviews the fluctuations in the value of ylang-ylang.

NOTES ON ENTOMOLOGY

MR. E. E. AUSTEN has produced another book on the tsetse-flies.¹ A few years ago

¹"A Handbook of the Tsetse Flies (Genus *Glossina*)," British Museum, 1911, 110 pp., 10 pls., 24 text figs., 1 map.

these flies were practically unknown to entomologists, and even specimens were rare in museums. Since their connection with disease has been proved, Mr. Austen has had the opportunity of examining thousands of specimens. The author adopts the division of the genus into three sections as proposed by Mr. Newstead, but does not rely as much as that author upon the structure of the genitalia for separating species. Fourteen species are recognized, and one considered uncertain. The puparia of six species are figured, and are all extremely similar in appearance. The illustrations (by Terzi) are all that one could desire.

AN interesting review of the fleas infesting the domestic animals is furnished by Dr. K. Wolffhügel.² Following a general account of the structure, habits and life-history of fleas, is a descriptive list of twelve species. The generic name *Dermatophilus* is used in place of *Sarcopsylla*, although the latter has four years priority. A host-list, and a bibliography is appended.

MR. H. ELTRINGHAM has issued a large book summarizing his studies on the mimetic butterflies of Africa.³ Each species is treated under the mimetic association of which it is considered a member. These associations are based upon certain general plans of coloration. He shows that many of these butterflies are distasteful to birds, and that the butterflies eaten or attacked by birds are mostly non-mimetic species.

MR. R. SHELFORD, who has published recently on the cockroaches of amber⁴ finds that all the genera are recent ones, and that one species, *Euthyrrhapha pacifica*, is the same as a species now widely distributed in the tropics, but never recorded from Europe. This is not a primitive cockroach, but a highly

specialized one. The specimen is marked much like the common form in South Africa. About ten species are described as new, some prettily maculated with yellow and brown.

MR. B. H. WALDEN is the author of the "Orthoptera of Connecticut" in the series which Professor Britton proposes to publish on the insect fauna of that state.⁵ There are descriptions and synoptic tables to genera and species, and many notes on the habits of the 100 species now known from that state. It will be a most useful work for the beginner, and if the other parts can be carried out in the same excellent manner the "Guide" will be one of the most valuable works on North American entomology.

RECENT parts of the "Catalogus Coleopterorum" are No. 29, Staphylinidae, Part II., pp. 87-190, by M. Bernhauer and K. Schubert; No. 30, Cioidea, 32 pp., by K. W. von Dalla Torre; one of our species *Cis bimaculatus* Kraus is changed to *C. krausi* because of preoccupation, and No. 31, also by Dalla Torre on the Aglycyderidae, one species from the Canary Islands, and the Proterrhinidae, only represented in the Hawaiian Islands; No. 32 on the Hydrosaphidae, by E. Csiki, 61 pp.; No. 33 by Dalla Torre on Nosendridae, Byrrhidae and Dermestidae, 96 pp.; No. 34 on Erotylidae, by P. Kuhn, 106 pp.; No. 35 by J. Weise, on the Hispinæ, 94 pp., and No. 36 on the Anthicidae, by M. Pic, 102 pp., these with many species in our country.

THE problem of the classification of the Coleoptera has been attacked from a new point by Dr. P. Netolitzky,⁶ who has investigated the structure of the paramera in a number of genera. These paramera, which are basal pieces of the male genital organs, are usually asymmetric in most of the Carabidae, in *Patrobus* and allies but slightly so, in

²"Die Flöhe (Siphonaptera) der Haustiere," *Zeitschr. Infektionskr., par. Krankh. Hyg. Haustiere*, VIII., pp. 218-236, 354-382, 25 figs., 1910.

³"African Mimetic Butterflies," Oxford, 1910, 136 pp., 10 pls. col.

⁴"The British Museum Collection of Blattidae Enclosed in Amber," *Journ. Linn. Soc. Lond. Zool.*, XXXII., pp. 59-69, 1 plate, 1911.

⁵"The Euplexoptera and Orthoptera of Connecticut; Guide, Insects Conn.," Part II., Bull. 16 State Geol. Nat. Hist. Survey, pp. 39-169, 5 plates, 1911.

⁶"Die Parameren und des System der Adephaga (Caraboides)," *Verh. zool.-bot. Ges. Wien*, 1911, pp. 221-239.

Pterostichus and *Pseudomorpha* very strongly asymmetric. In *Carabus*, *Calosoma* and *Cychrus* they are symmetric, and also in some families allied to the *Carabidæ*. He considers these parts will furnish useful clues to the relationship of families and smaller groups.

DR. C. WESENBERG LUND, who has been studying the habits of caddice flies has recently published two articles on the larvæ. In one⁷ he describes and figures the nets of most of the Hydropsychidæ found in Denmark, and also describes the structure of the larvæ. He considers the Rhyacophilidæ an ancient family, and the Hydropsychidæ a more recent and highly specialized one.

In the second article⁸ he gives an account of the life-history and larval habits of a large and common caddice-fly. The carnivorous larva builds a spiral case of parts of leaves or sticks, which is gradually enlarged and lengthened as the creature increases in size.

Useful bibliographies accompany each paper.

DR. N. ANNANDALE has described⁹ a new genus (*Ramcia*) which is intermediate between the true mosquitoes and the series of genera known as *Corethinæ*. The proboscis is short and weak, but the veins of wings bear prominent scales, and the entire wing-margin is provided with a fringe of long scales. There are no scales on the thorax. The larva and pupa are also described, being related to *Corethra*. The single species comes from Ceylon.

AMONG recent fascicles of the "Genera Insectorum" of M. Wytsman, a number are of interest to us. Fascicle 110, by H. Schmidt,

"Biologische Studien über netzspinnende Trichopterenlarven," *Intern. Rev. Hydrobiol. Hydrol.* (Biol. Suppl., III. Ser.), V., pp. 1-64, 1911, 5 pls.

"Ueber die Biologie der *Phryganea grandis* und über die Mechanik ihres Gehäusebaues," *Intern. Rev. Hydrobiol. Hydrol.*, IV., pp. 65-91, 2 pls., 1910.

"A New Genus of Short-beaked Gnats from Ceylon," *Spolia Zeylanica*, VII., pp. 187-193, 1 plate, 1911.

is on the Aphodiidæ (part of the old Scarabæidæ), 155 pp., 3 pls.; fasc. 111, by Max Hagedorn, on the Ipidæ (Scolytidæ), 178 pp., 14 pls.; three of the plates show galleries and four show structural details; fasc. 113 on the Orthalid flies of the sub-family Richardinæ, 56 pp., 3 pls.; fasc. 114, by G. V. Szepligeti, on part of the ichneumon flies of the Ophiinidæ, 100 pp., 2 pls.; fasc. 115, by R. Martin, on the Æschminæ, 34 pp., 5 pls.; fasc. 116, 117, by P. Dupius, on two small groups of Carabidæ; fasc. 118, by C. Emery, on the ants (Formicidæ) of family Ponerinæ, 125 pp., 3 pls.; fasc. 119, by J. A. G. Rehn, on the Mantid sub-family Vatinæ, 28 pp., 1 pl.; fasc. 120, by A. N. Caudell, on a small group of Locustidæ; fasc. 121, by W. D. Pierce, on the Strepsiptera, 54 pp., 5 pls.

NATHAN BANKS

SPECIAL ARTICLES

NOTICE OF A NEW GENUS OF RHINOCEROS FROM THE LOWER MIOCENE

DURING the past few years, several of the many collectors from various institutions, who have collected in western Nebraska and eastern Wyoming, have found fragments of a very large rhinoceros in the Harrison beds, which occur in that region. Mr. E. S. Riggs, of the Field Museum of Natural History, of Chicago, found certain upper molars which he took to be those of some primitive species of *Teleoceras*. But all of these "finds" have been quite fragmentary, and no particular attempt has been made to accurately classify them.

The writer had the good fortune last summer to find additional material of this type, and upon careful examination is convinced that a new genus—or at least a new sub-genus—is here represented.

Epiaphelops virgasectus, gen. et sp. nov.

Dental formula, $M_3^?$, $P_4^?$, $C_0^?$, $I_1^?$. Type No.

H O 265, collection of the writer. The specimen taken as the type is a right lower jaw, with complete dentition, and the anterior part of the left lower jaw.

Epiaphelops is separated from *Aphelops*, to

which genus it appears most nearly related, by (1) the presence of a functional P_1 of good size. This tooth is absent in *Aphelops*; (2) by a much more brachydont dentition; (3) by the presence of a heavy external and internal cingulum on all teeth of the grinding series, but the last molar, where it is reduced.

This brachydont condition, as compared with *Aphelops*, corresponds to the difference in horizon, assuming them to be in the same approximate ancestral line. The typical *Aphelops megalodum* is from the Middle Miocene, the present genus and species from the Lower Miocene.

Epiaphelops does not appear to be derivable from *Cænopus*, as in all known species of *Cænopus* the first lower premolar is absent, or a vestigial, variable, character. In this respect *Epiaphelops* is more primitive than *Cænopus*, as P_1 is large and functional. Comparison with other Oligocene types does not appear profitable.

Epiaphelops virgascus is somewhat larger than *Aphelops megalodum*. As the other specimens in the collection of the writer referable to this type are not surely associated, they are best unpublished for the present, but suffice it to say that when this form is better known, other characters are present which will more clearly characterize it. A more complete description will appear later.

HAROLD JAMES COOK

AGATE, NEBRASKA,

December 20, 1911

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE
SECTION A—MATHEMATICS AND
ASTRONOMY

As the Astronomical and Astrophysical Society of America held a regular meeting in affiliation with the American Association, and as the American Mathematical Society held its annual meeting at the same time in New York City, the special program of Section A was confined to one session. This was a joint session with the Astronomical and Astrophysical Society, and the program consisted of the vice-presidential address by E. H.

Moore, of the University of Chicago, and of two papers given, on special invitation, by J. A. Metcalf and Lewis Boss.

An abstract of the paper by Lewis Boss, entitled "Recent Researches as to the Systematic Motions of the Stars," is as follows:

The proper motions of stars are so small, and are so difficult to measure with proportionate accuracy that the successful determination of systematic peculiarities in the arrangements of the motions themselves must depend upon great systematic accuracy in the measurements of those motions. Therefore, when the department of meridian astrometry was established at the Dudley Observatory about six years ago with the support of the Carnegie Institution of Washington its first work of investigation was to continue to completion the work it had begun with the object of ascertaining the proper motions of the brighter stars which had been most observed with precision in the past, with all practicable completeness and accuracy, both in the casual and systematic sense, with the ultimate purpose of making this work the basis of studying the systematic peculiarities of these motions in order to throw further light on the mechanism of the visible universe.

About two years ago the Carnegie Institution of Washington published the result of this research in a volume entitled "Preliminary Catalogue of 6,188 Stars." For each star the position was given for 1900 together with the proper motion, etc., necessary for reducing those positions to any other epoch. This material was first employed for deriving new values of the precession as well as the direction of solar motion. The latter was found to be, for 1875: R.A. $270^\circ.7$, Decl. $+34^\circ.3$ (A.J. 614). The stars employed in this discussion cover the entire sky from the north to the south pole; so that the direction of the solar motion came out with very great weight and at the same time independently of the precession.

Next were deduced the facts in regard to an interesting moving cluster of stars in the constellation, *Taurus*. Each of the 41 stars appears to be moving toward a point in the sky in R.A. $6^h 7^m$, Decl. $+7^\circ$. The velocities of motion of the several stars are approximately the same. Very recently Mr. Benjamin Boss, of the department of meridian astrometry, identified a group of 11 or 12 large proper motions scattered widely over the sky between declinations $+42^\circ$ and -81° , which converge nearly in a point at R.A. $6^h 37^m$, Decl. $+0^\circ.5$. The velocities of these stars toward the point cited seem to be uniformly about 95

kilometers per second. 61 *Cygni* appears to be a member of this group (A.J. 629).

Before seeking a systematic representation in direction and amount of the star motions generally the speaker had wished first to follow up the indications which had already appeared to the effect that the stars of differing spectral types are moving with differing mean velocities. Frost, eight years ago, had offered the earliest evidence that the Helium, or *Orion*, stars are moving slowly in comparison with those of older types. Quite recently he and Kapteyn and also Campbell added some preliminary evidence to the discussion of this question. In the winter of 1910-11 the department determined to take up this subject comprehensively by employing the cross-motion element of the proper motions. The results of this research on acceleration of stellar motion were published in the *Astronomical Journal*, Nos. 623 and 624. These results are given in the following table under the column designated "mean cross motions." For comparison, Campbell's results from mean radial motions are given in the next column. They were obtained from entirely different sources, independently and almost simultaneously. The letters in the first column, in which *B* is supposed to stand for the youngest spectral type (Helium), and *M* for the oldest considered in this investigation, are designations adopted from the Harvard classification (H. C. O., Vol. L.).

Type	Mean Cross Motions	Mean Radial Motions
<i>B</i>	6.3	6.2
<i>A</i>	10.2	10.5
<i>F</i>	16.2	14.4
<i>G</i>	18.6	15.9
<i>K</i>	15.1	16.8
<i>M</i>	17.1	17.1

The cross motions were originally expressed as a fractional part of the centennial motion of the sun. Both series, in good agreement, express the fact that the motion of a star accelerates up to about the time the spectrum develops into type *F* or *G*, after which it seems to gain no increase of velocity.

Seven years ago Professor Kapteyn, at the Scientific Congress of the St. Louis Exposition, introduced his now well-known hypothesis that the visible universe consists of two great intermingling streams moving in opposite directions. The direction of one he called the "vertex," which he fixed at R.A. $6^h 4^m$, Decl. $+13^\circ$. Quite recently Edding-

ton, of the Greenwich Observatory, with the same hypothesis, and using the proper motions of the "Preliminary General Catalogue," found for this vertex: R.A. $6^h 16^m$, Decl. $+12^\circ$.

In 1907 Schwarzschild advanced the hypothesis that a systematic arrangement of the proper motions leads to an ellipsoidal arrangement of distribution and he endeavored to show that the proper motions of Groombridge's Catalogue are as well represented as they are by the hypothesis of two streams.

By a method entirely different from that employed by either of the two investigators, the department found nearly a year ago that when its proper motions were compared in a manner to bring out this systematic arrangement, it was seen that if all the actual motions of the stars in any considerable area of sky were brought to a common origin (freed from their solar parallactic motions) the figures so constructed would have an elliptic outline, which turned out to be different presentations of an ellipsoidal figure of which, if the major axis be taken as 7, the two minor axes would be 4. The major axis of all the figures points very nearly toward the vertex of Kapteyn; this point was found to be in R.A. $6^h 15^m$ and Decl. $+7^\circ$. Moreover, these ellipsoids have well-marked nuclei composed chiefly of stars of types *B* and *A*. This fact would require a third stream to complete the "two-stream" hypothesis, as some of the supporters of the latter have already perceived.

The speaker presented considerations in support of his belief that this ellipsoidal arrangement of the star-motions in space would be reduced to a simple and natural explanation, if we suppose that the stars had been originally formed in nebulae and repelled from the regions of their formation with a tendency to be impelled by some kind of polarity 50 to 75 per cent. faster in the direction of the major axis of the ellipsoid than in a direction at right angles to that. This hypothesis also fits in well with the undoubted phenomenon of acceleration of a star's motion with age.

The section elected President E. O. Lovett member of the council, Professor F. B. Littell member of the sectional committee, and Dean H. T. Eddy member of the general committee. On recommendation of the sectional committee Professor E. B. Van Vleck, University of Wisconsin, was elected chairman of the section by the general committee.

G. A. MILLER,

Secretary of Section A

UNIVERSITY OF ILLINOIS

THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE eighth annual meeting of the association was held in Washington, December 28-30, 1911. Through the kindness of the National Geographic Society, the sessions were held in Hubbard Memorial Hall, and luncheon was provided for those in attendance.

The president, Professor Ralph S. Tarr, of Cornell University, presided, and gave the president's address. His subject was "The Glaciers and Glaciation of Alaska." Professor Martin read a memorial of Professor Christopher Webber Hall, who died on May 10, 1911. In addition to these addresses, thirty-six papers were read by members and by several others on invitation. Paper on subjects in meteorology were more numerous than at any previous meeting of the association.

On Friday evening the association met with the Geological Society of America to hear the address of its president, Professor W. M. Davis, upon the subject "The Relations of Geology and Geography." This was followed by a smoker given to both societies at the Cosmos Club by the Geological Society of Washington.

The first volume of the *Annals* of the association is now in press and will appear during the winter under the editorship of Professor R. E. Dodge. Announcement was made of the election of the following officers for the year 1912: *President*, Rollin D. Salisbury; *First Vice-president*, Marius R. Campbell; *Second Vice-president*, Isaiah Bowman; *Secretary*, Albert Perry Brigham; *Treasurer*, Nevin M. Fenneman; *Councillor for three years*, Lawrence Martin. The next annual meeting will be held in New Haven.

ALBERT PERRY BRIGHAM,
Secretary

THE SOCIETY OF AMERICAN BACTERIOLOGISTS

AT the Washington meeting of the society from December 27-29, the following papers were presented:

Biochemical Problems in Bacteriology (president's address): F. P. GORHAM.

This address will appear in *SCIENCE*.

The Classification of the Streptococci by their Action upon Carbohydrate Media: C.-E. A. WINSLOW.

When Gordon first suggested the use of carbohydrate media for differentiating streptococci, it

seemed that this long-mooted problem was at last likely to be solved. The work of the last five years has, however, left matters in almost as confused a condition as ever, since different observers obtain such varied, and in some cases, conflicting results.

The author attempts to review in this paper the results of four recent American investigations, including 302 fecal streptococci, studied by Winslow and Palmer, 101 milk streptococci studied by Broadhurst, 65 throat cultures studied by Hilliard and 17 cultures from various sources examined by Bellinger, of Meadville College.

In all these cases the amount of acidity produced was determined by titration. The first point brought out is that the dividing line between fermenting and non-fermenting strains lies at about 1.2 per cent. acidity. The English results obtained by Gordon and Houston have been obtained by the use of litmus without titration, and if their solutions were not exactly neutral at the start, they must have classified as fermenting many organisms which really belong to the non-fermenting class. A careful comparison of the English results for particular groups shows, indeed, that they include a much greater percentage of positive records than the American ones.

Experience seems to indicate that systematic studies of the carbohydrate relations of the streptococci should be carried out by titration with phenolphthalein as an indicator. Media may be made up from meat extract (each batch checked by controls inoculated with *B. coli*) and adjusted to an initial reaction between neutral and .5 per cent. acid. Dextrose, lactose, saccharose, salicin, inulin, mannite and raffinose should all be used for diagnosis for the present at least, and titration may be made after cultivation for three days at 37° C.

When studied in this way, cultures producing over 1.2 per cent. acidity more than that initially recorded being considered positive, the media are acted upon (with occasional exception) in accordance with a definite order of fermentability, which is quite different from the order which prevails in the colon group. If only one carbohydrate is attacked that one is usually dextrose. Lactose and saccharose come next and particularly with fecal streptococci. Salicin is almost as commonly acted upon. Mannite is rarely attacked except by streptococci from milk and human feces, while raffinose is rarely attacked except by organisms from bovine feces. Inulin fermenters occur only abundantly

dantly in milk. These facts correspond with the chemical relationships of the sugars, the monosaccharide and disaccharide being most readily attacked, next the glucoside, salicin, which breaks up into a simple sugar, while the more complex carbohydrates are less available. The streptococci form a more or less continuous series from those which attack no sugar at all to those which ferment all the carbohydrates tested. Occasionally a strain reacts with a substance lower in the series of fermentability while failing to do so in a sugar usually more available, but this is rare. Characteristic forms appear in the throat and in the feces of man and other animals, so that the method promises to prove of practical as well as theoretical value.

A Comparison of Streptococci from Milk and from the Human Throat: E. C. STOWELL and C. M. HILLIARD.

The present study of throat and milk streptococci was undertaken with the object of establishing a method for distinguishing between organisms isolated from the two sources. (The small number of strains examined (70) renders any present generalizations only tentative.)

The streptococci used were all isolated from fresh specimens in our laboratory by cultural and morphological examinations. Quantitative acid production was studied in six carbohydrate media; dextrose, maltose, lactose, saccharose, raffinose and mannite. The tubes were incubated at 37° and at 20 degrees for 72 hours. The maltose results are neglected in the present discussion.

Below 1.2 per cent. acid production at 37° is considered a negative reaction. All but four cultures on this basis fermented one or more of the carbohydrates; 83 per cent. may be placed in three groups according to the correlation of their capacity to ferment the media used. The following table shows this distribution:

Fermented	Per Cent. Throat Cultures	Per Cent. Milk Cultures
Dextrose only	22.2	6.3
Dextrose and lactose	20.4	38.0
Dextrose, lactose, saccharose ...	33.1	57.7

Grown at 20° the first reaction mode falls at 0.5 per cent. and on this basis the milk cultures fall into the same general groups as shown above, but the throat streptococci show 50 per cent. not to ferment at all, and 40 per cent. to ferment dextrose only.

A comparative study of the cultures isolated from sore, inflamed, or otherwise "abnormal" throats and from normal throats showed no essential differences; the reaction curves follow the same general contours throughout.

(No clue to the relationship of the forms studied was obtained from the morphology or staining reactions.)

Our work leads us to make three preliminary conclusions:

1. Streptococci from the human throat and from milk very generally ferment one or more of the sugars, dextrose, lactose and saccharose, attacking them most readily in the order named. They do not generally ferment raffinose or mannite.
2. The streptococci of the sore and the normal throat show no cultural differentiation in relation to the carbohydrates used. Virulence tests would perhaps have separated the two groups.
3. Milk streptococci are much more facultative than throat strains in relation to the temperature at which they are grown. This is, perhaps, the most valuable information obtained as a differential feature between chained cocci from the two sources.

A Study of Thirty-five Strains of Streptococci Isolated from Samples of Milk: GUSTAV F. RUEDIGER.

The paper points out that *Streptococcus lacticus* can be differentiated from *Streptococcus pyogenes* by means of blood-agar plates. *Streptococcus pyogenes* produces small colonies surrounded by a large zone of hemolysis, whereas *Streptococcus lacticus* produces green or grayish colonies with very little or no hemolysis.

Streptococcus lacticus has no sanitary significance, as it is found in nearly all samples of clean, soured, or fresh milk, and very often in the healthy milk ducts. *Streptococcus pyogenes*, on the other hand, seems to occur but rarely in milk and is indicative of the existence of an inflamed condition of the udder of the cow furnishing the milk.

A Biometrical Study of Milk Streptococci: JEAN BROADHURST.

This comparative study of carbohydrate fermentative reactions is based upon streptococci isolated from milk plates which were made in the routine milk examination by the New York Department of Health. One hundred strains were isolated, and as rapidly as purity was assured transferred to eight of the Gordon test media:

neutral red for reduction, milk for coagulation, and the following carbohydrates for acid formation: saccharose, lactose, salicin, inulin, mannit and raffinose.

Neutral red has since been discarded by Houston as not sufficiently diagnostic. Milk is apparently open to the same objection.

Only the six carbohydrates therefore remain for consideration. Houston used them all (and coniferin) in his milk tests, but secured qualitative results only. Quantitative ones have been recorded for 300 fecal (human, bovine and equine) strains by Winslow and Palmer for dextrose, lactose, raffinose and mannit.

Sugar-free broth was used, and the streptococci therefore began their growth with an initial acidity of 1.3 to 2.2 per cent. (deducted from all recorded results). After 72 hours' growth, titration (with phenolphthalein) showed the following results:

1. Non-fermenting and fermenting groups are found for each of the six carbohydrates tested. The dividing line lies near 1.5 per cent. (higher than among the fecal streptococci).

2. Streptococci ferment these carbohydrates in a large percentage of the strains: lactose, 74 per cent.; saccharose, 68 per cent.; salicin, 77 per cent.; inulin, 37 per cent.; mannite, 26 per cent., and raffinose, 13 per cent.

3. The amount of acid is remarkably large (highest in saccharose, 8.4 per cent.).

4. The reaction combinations observed are numerous, and therefore small: 4 groups of 10 or more strains, and 4 of 5 to 9 strains; these include about 75 per cent. of the strains.

5. These reaction groups are apparently not correlated with morphological characters.

6. The high records for acidity are even more remarkable when the initial acidity is considered.

DISCUSSION OF STREPTOCOCCI

W. L. Holman referred briefly to the Andrade indicator—acid fuchsin decolorized by sodium hydrate—as used in the pathological laboratories in Pittsburgh. He spoke of the differential media for streptococci in use by them, viz., blood agar, lactose, mannit, salicin and inulin broth and laid particular stress on the fermentation or non-fermentation of the various carbohydrates, believing that of greater importance than the exact titration of acidity produced. The use of the hemolytic test he advocated as of great importance in separating two large groups of the streptococci.

A Study of the Diphtheria Group by the Biometric Method: M. E. MORSE.

This study was undertaken for the Boston State Hospital at the instance of Dr. E. E. Southward. The writer is greatly indebted to Professor C. E. A. Winslow for assistance.

The characteristics which were chosen as the basis of classification were:

- A. Morphology. The cultures of diphtheria bacilli were grouped as granular, segmented and those in which solid and small granular forms predominated.

- B. Vigor of growth.

- C. Chromogenesis.

- D. Quantitative determination of acidity in 1 per cent. dextrose, maltose, glycerin, saccharose and dextrin broth.

- E. Virulence (guinea-pig inoculation).

- F. Toxin production.

- G. Immunity reaction (fixation of complement and conglutination). This part of the work is still in progress, and will be reported later.

187 strains of Klebs-Loeffler bacilli, 76 of diphtheroids and 23 of Hoffmann's bacillus have been studied.

RESULTS. I. DIPHTHERIA GROUP

A study of the relationship between morphology and virulence shows that 61 per cent. of the granular cultures were virulent, and only 34 per cent. of the segmented cultures. The solid and small granular cultures were, with one exception, non-virulent.

The group of virulent diphtheria bacilli forms more acid in dextrose, maltose and dextrin broth, than does the non-virulent group.

There are forms sharing the characteristics both of the Klebs-Loeffler group and the diphtheroids.

II. DIPHTHEROID GROUP

The common diphtheroids found on the human body fall into three sub-groups.

Group A.—The so-called "Hoagbacillus." Medium-sized bacillus with solid, barred and wedge forms. On serum, a very heavy glistening salmon-pink growth. Ferments dextrose and saccharose always, maltose and glycerin infrequently; and never dextrin.

Group B.—Morphologically larger and thicker than "Hoagbacillus"; forms with clear-cut bars predominate. On serum, a heavy yellow, dry growth. Ferments dextrose, but not saccharose; usually maltose, glycerin frequently.

Group C.—Differentiated primarily by slow, scanty, colorless or white growth. Morphologically smaller than organisms of group *B*; thick, curved, with solid, barred and wedge forms. Ferments dextrose, always; saccharose usually, maltose and glycerin in 50 per cent. of cultures. The xerosis bacillus apparently belongs to this group.

CONCLUSIONS

1. The division of diphtheria bacilli into virulent and non-virulent varieties is justified by differences in morphology and degree of fermentative powers, and by the absence of intermediate grades of virulence, as shown by animal inoculations.

2. The common "diphtheroid" organisms found in the human body fall into three sub-groups.

3. B. Hoffmann's has no biological relationship either to the diphtheria bacillus or to the diphtheroids.

A Biometric Investigation of Certain Non-spore-forming Intestinal Bacilli: EUGENE C. HOWE.

Six hundred and thirty strains of intestinal bacilli were collected from stools of twenty-one individuals—mostly healthy men. These were subjected to the following quantitative tests: (1) Acid and gas formation in dextrose, lactose, saccharose, raffinose, levulose, mannite and dulcitol. (2) Acid production in milk. (3) Digestion of starch. (4) Production of indol from peptone. (5) Reduction of nitrates. (6) Gelatin liquefaction. (7) Morphology. (8) Motility.

The resulting data were analyzed statistically with the following conclusions to date relative to the non-gelatin liquefiers (540 strains):

1. Confirmation of the accepted view that motility has not systematic significance within the group "*B. coli* and closely related organisms."

2. Lack of classificatory value of amount of gas produced and "gas ratio."

3. Acid formation, a sounder criterion than production of gas.

4. Mannite, dulcitol and starch of little value in classification of this group, in connection with the other tests used. There is no correlation between the first three and the latter.

5. Indol, ammonia, and nitrite formation but slightly correlated with the general robustness of the organism and of little significance in classification within this group.

6. Dextrose, lactose, saccharose and raffinose constitute a natural *metabolic gradient*. Fermentation of any member of the series implies fermentation of members lower in the series.

7. On this basis there are two main groups of dextrose fermenting, gelatin-minus, non-spore-forming, intestinal bacilli and four sub-groups.

- | | |
|------------|---|
| I. (58 %) | { Dex. + Lact. + Sac. + Raf. + 1 (53 %) |
| | { Dex. + Lact. + Sac. + Raf. — 2 (5 %) |
| II. (42 %) | { Dex. + Lact. + Sac. + Raf. — 3 (41 %) |
| | { Dex. + Lact. — Sac. — Raf. — 4 (1 %) |

The Green Fluorescent Bacteria of Maple Sap:

H. A. EDSON and C. W. CARPENTER.

Green fluorescent bacteria are the most important agents in the deterioration of maple sap. These microorganisms feed upon the traces of protein present in the sap, but have little, if any, action upon the sugar. The sap becomes cloudy with more or less green color and produces an inferior quality of syrup and sugar.

Forty-two strains of this group of bacteria which were isolated from maple sap, together with five cultures of known species from Kral and one from Novy, were studied. The latter were: *B. fluorescens albus*, *B. fluorescens liquefaciens*, *B. fluorescens longus*, *B. fluorescens mesentericus*, *B. fluorescens tenuis* and *B. fluorescens putidis*. The chief differences observed in the entire series of cultures were in respect to the following characters: nitrate reduction; growth on synthetic media; gelatin liquefaction and casein digestion in milk; hydrogen sulphide production; temperature relations.

Thirty-three strains of the fluorescent sap bacteria agree closely with *B. fluorescens liquefaciens*; two strains resemble *B. fluorescens mesentericus* and seven strains are similar to *B. fluorescens tenuis*.

Bacterial Variation Due to Acidity and Flow in the Youghiogheny River at McKeesport, Pennsylvania: E. C. TRAX.

The germicidal action of drainage from coal mines, containing as it does free sulphuric acid and iron in solution, is indicated by its composition.

Experiments made by the Department of Health of Pennsylvania lead to the conclusion that "Mine water will prevent the growth of typhoid bacilli after the lapse of one hour, and will markedly limit the growth of colon bacilli so that they die off progressively and can not be cultivated after 24 hours."

The acidity of the water in the Youghiogheny River is caused by the acid mine drainage, an immense quantity of which is discharged into the river and its tributaries. The reaction of the

water at McKeesport ranges from 20 parts per million alkaline during high stage of water to 39 parts acid at low stage, and the bacterial life of the stream is directly affected thereby.

The monthly averages of bacteria per cubic centimeter, acidity and height of river, are given below for the year 1910:

Month 1910	Av. Acidity (a)	No. Bacteria per c.c. (b)	Stage of River (c)
January	11	31,000	5.3
February	37	20,000	3.4
March	36	21,000	3.1
April	52	12,000	1.8
May	23	2,000	1.6
June	6	6,500	3.3
July	65	205	0.7
August	182	9	0.1
September . . .	113	97	—0.2
October	240	240	—0.1
November . . .	176	160	0.1
December . . .	29	2,400	2.0

(a) Acidity to methyl orange in parts per million.

(b) 48 hours' incubation at 20° C.

(c) Gauge height in feet at West Newton.

It can be stated in a general way that the bacterial numbers vary with the gauge height of the river and inversely as the acidity. The acidity of the water is controlled by the conditions of rainfall, run off and flow, inasmuch as these are the factors which affect the dilution of the mine drainage. Allowing for the natural fluctuation of bacterial life in a flowing stream, the presence of the mine water is responsible for a considerable reduction at all times except during floods, when the water is alkaline, while during high acidity the effect approaches sterilization.

Water Sterilization by Emergency Chlorinated Lime Treatment Plants: RALPH E. IRWIN.

When emergencies call for the immediate sterilization of a public domestic water supply, temporary treatment apparatus may be constructed by using barrels to mix and feed chlorinated lime into the suction main, suction well or point where the water passes and thorough mixing is insured.

The solution may be mixed and settled in one barrel and fed from another *via* regulating valves. With this crude device water from large and small streams, wells and springs have been disinfected and communities protected from water-borne disease.

Two examples are given showing the bacteriological results obtained by treating similar spring waters that were infected and had caused epidemics of a water-borne disease.

The first spring furnished 1 to 1.5 million gallons daily and was under municipal control where political protection was given inefficient employees. During a period of 115 days, bacteriological determinations were made showing the total number of bacteria and *B. coli* present in 85 samples of untreated water from the spring, 70 samples of treated water as it left the pump and 75 samples from taps about the city. On 8 days samples were obtained showing *B. coli* in such large numbers that it was evident little, if any, lime was being added. The results as a whole show, however, that the prescribed 6 to 8 pounds of high-grade chlorinated lime per million gallons was sufficient to sterilize the water if added as directed.

The second spring furnished 3 to 3.5 million gallons daily and was under strict corporate control with employees obeying orders. During a period of 103 days, bacteriological determinations were made showing the total number of bacteria and *B. coli* present in 36 samples of untreated water from the spring and 36 samples of treated water from taps on the pump or distributing system. The treated water showed excellent reductions in total counts in every instance, and *B. coli* were absent throughout the period of treatment.

With a crude device such as described in the hands of efficient workmen during emergencies, creditable results may be obtained and valuable protection given.

The Distribution of Bacteria in Certain New York Soils: H. J. CONN.

Extensive work for two years with a certain clay loam at Ithaca has resulted in the isolation and study of about five hundred cultures. These cultures have been classified into thirty-four types, which are essentially species. Grouping these types into six easily distinguished classes, their relative frequency can be thus stated:

5-10 per cent. spore-producing liquefiers; large rods (*e. g.*, *B. subtilis* and *B. mycoides*).

5-10 per cent. non-spore-producing, rapid liquefiers; small rods with polar flagella (*e. g.*, *Ps. fluorescens*).

40-70 per cent. non-spore-producing, slow liquefiers; short rods, immotile (except one with polar flagella); growing very poorly in ordinary laboratory media.

Ca. 10 per cent. non-spore-producing, non-liquefiers; short rods, immotile or with polar flagella.

Trace. Micrococci, like the last group physiologically.

15-45 per cent. Actinomycetes.

Of these six groups all are strict aerobes except a few in group 1; almost without exception none produce gas from sugars; while acid production, although common, is always very weak.

Each group comprises about seven or eight types, except the last two, in which there are but one or two types.

This year forty more cultures have been isolated from four other soils elsewhere in the state. Two were clays, one a silt and the other a sand. With few exceptions these cultures seem to be the same kinds as those previously studied, although the relative frequency of the types is different. This suggests that there is a characteristic bacterial flora of soil. Accordingly, an intelligent comparison of soils demands the development of a technique to determine the relative abundance of the various kinds of organisms.

Soil Organisms which Destroy Cellulose: KARL F. KELLERMAN and I. G. MCBETH.

Our knowledge of cellulose destruction in soils is inadequate. Omeliansky's conclusions that cellulose is destroyed only under anaerobic conditions and gives rise either to hydrogen or methane are erroneous.

Two species of cellulose-destroying and five species of contaminating bacteria were isolated from Omeliansky's hydrogen culture, and one cellulose-destroying and two contaminating forms from his methane culture; none of the three species showed any resemblance to Omeliansky's hydrogen or methane ferments. In addition to the species isolated from Omeliansky's cultures eleven other species have been isolated from various other sources, one of which belongs to the thermophile group.

Contrary to Omeliansky's observation that cellulose-destroying bacteria do not grow upon solid media, most of the species isolated were found to grow readily upon such media as beef agar, gelatin, starch, potato and dextrose. Some of them have the power to liquefy gelatin. Although several of these organisms were isolated under anaerobic conditions, they grow equally well or better in the presence of air, which shows that the destruction of cellulose by bacteria is an aerobic rather than an anaerobic process.

It is usually supposed that filamentous fungi

are of little importance in agricultural soils; these investigations show them to be at least as important as bacteria in destroying cellulose. About seventy-five species of molds have been isolated representing a large number of genera; species of *Penicillium*, *Aspergillus* and *Fusarium* are perhaps most numerous.

In the destruction of pure cellulose either by bacteria or molds in synthetic media the associative action of organisms which presumably have no cellulose-dissolving enzymes frequently stimulates the growth of the cellulose organism and increases its destructive power.

Nitrates in Soils: F. L. STEVENS.

Nearly all text-books assert that nitrates are the chief source of nitrogen supply for green plants. Recent experiments throw doubt on this assertion. Attention was called to the need of tests bacterially and chemically controlled, conducted under natural conditions, to determine what forms of nitrogen are most readily available to the leading crop plants. Nitrification and denitrification were discussed. In particular question was raised as to the influence of organic matter mixed with nitrates in fertilizers (a common practise) upon loss by denitrification. Stress was laid upon the need of conducting tests in soils, not in solutions.

Why do some Soils Nitrify Organic Nitrogenous Substances and the Ammonium Salts of Organic Acids Faster than they do Ammonium Sulphate or Ammonium Chloride? J. C. TEMPLE.

Of 26 Georgia soils tested for nitrification, 24 were found to nitrify tankage more readily than ammonium sulphate, in some cases the amount of nitrate recovered from tankage was ten times that recovered when ammonium sulphate was the source of nitrogen. Tankage, cotton-seed meal, cowpea vines, gelatin, peptone, asparagin, urea, ammonium citrate, ammonium oxalate, ammonium tartrate, ammonium bicarbonate and ammonium hydrate were nitrified faster than ammonium sulphate or chloride. This condition was not due to the nature of the nitrifying organism in the soil, as the same thing held true when the nitrifying organisms were supplied as pure cultures, obtained from a number of sources. When calcium carbonate was added to the soil, ammonium sulphate was nitrified as well as any of the other substances.

The explanation offered for this condition was that these soils (all of the Cecil group) were acid, and that the soil organisms decomposed the substances of organic origin in a way that more ammonia than acid was produced, thus correcting

the acidity and bringing about a condition favorable for the growth of the nitrifying organisms. When ammonium sulphate or ammonium chloride was added to the soil there was no chance for a similar decomposition and the soils remained acid.

Bacteriological Studies of the Fixation of Nitrogen in Certain Colorado Soils: WALTER G. SACRETT.

The power to fix atmospheric nitrogen is a property common to many cultivated Colorado soils.

This power is not confined to the fixation of nitrogen in solutions, but is manifested in soils as well.

"The rate of fixation of nitrogen obtained is sufficient to account for the nitrates found in the soil provided that it is nitrified. The rate of nitrification obtained is sufficient to account for the formation of the nitrates found in most cases, if not all of them."

The nitrates formed are sufficient to destroy all vegetation, in one case amounting to 172 tons per acre in the surface five inches.

The nitrogen-fixing power is not confined to any geographical locality or class of soils, however, the adobe shale soils, both in a raw state and when newly cultivated, possess little, if any, nitrogen-fixing power.

Excessive nitrates either destroy or greatly attenuate the nitrogen-fixing flora of a soil.

A limited amount of soil nitrate does not seriously affect the nitrogen-fixing power of a soil.

Azotobacter chroococcum appears to be the dominant nitrogen-fixing organism in the soils studied.

The dark brown color of the niter soils is due, in a large part, to the pigment produced by *Azotobacter chroococcum*.

Given a source of energy, the nitrate is the limiting factor in the production of the brown color.

In the presence of nitrates, *Azotobacter chroococcum* develops a chocolate brown to black pigment; nitrites, in certain amounts, produce similar results, but to a less degree; nitrogen as NH_4Cl , $(\text{NH}_4)_2\text{SO}_4$, asparagin, and peptone has no effect upon this function.

The highly colored extracts obtained from certain niter soils suggests that the pigment of *Azotobacter chroococcum* may be soluble in the alkaline soil waters.

Excessive soil moisture, by interfering with the growth of *Azotobacter chroococcum*, prevents the formation of the brown color on the soil, and makes the fixation of atmospheric nitrogen impossible.

Excessive irrigation, too diligent cultivation and the alkaline reaction of our soils appear to favor unduly the growth of *Azotobacter*.

This paper is published in full as Bulletin 179 of the Colorado Experiment Station, Fort Collins, Colorado.

The Movement of Nitric Nitrogen in Soil: ROBERT STEWART and J. E. GREAVES.

In the work which has been conducted for eight years at the Utah Experiment Station upon the influence of irrigation water upon the production and movement of nitric nitrogen in the soil, there has been observed a variation in the nitric nitrogen content of the soil and the concentration of the soil solution with the water applied, the crop grown and with the season.

The soil upon which these investigations have been conducted is ideally adapted both chemically and bacteriologically to support a rapid bacterial action, yet the amount of nitric nitrogen present to a depth of ten feet does not exceed three hundred pounds per acre.

Deposits of nitrates do occur in the country rock in widely distributed areas in western America.

The careful analytical work reported by Dr. Headen on the composition of Colorado soils indicates a close relationship between the nitric nitrogen and chlorine content of these soils, indicating clearly a common origin of these two elements.

The Present Status of Soil Inoculation: KARL F. KELLERMAN.

The method of pure-culture inoculation is less certain than the use of soil from old well-inoculated fields, but has, however, the advantage of cheapness and greater ease of transportation and application, as well as the important advantage of the absence of introducing weeds and plant diseases. The crown-gall disease of fruit trees is the most conspicuous example of disease which may be disseminated by soil transfer.

Reports received from farmers who have conducted inoculation tests with cultures distributed by the Department of Agriculture during the past seven years give an average of 76 per cent. success and 24 per cent. failure, if only those reports are considered that make possible some determination regarding the action of cultures. If previously inoculated fields, crop failures and such other doubtful cases are included with the failures our percentage of success for this same period is reduced to 38.

The organism producing nitrogen-fixing nodules on the roots of legumes has been isolated and cultivated since 1903; di Rossi's contention that the proper organism had not been isolated prior to his work in 1907 appears without foundation.

By a new technique it has been possible to stain the flagella of this organism. Instead of bearing a single polar flagellum it is supplied with several peritrichic flagella. The proper designation of this organism, therefore, is *Bacillus radicolica*.

The Persistence and Vitality of Bacteria on Alfalfa Seed: M. J. PRUCHA.

The seeds of the common farm crops such as wheat, corn, peas, alfalfa, etc., are extremely difficult to sterilize without killing the seed. It has also been shown that the bacteria of disease are carried on beans and corn. It is important to know to what extent bacteria may persist on the seed.

The following results were obtained from a quantitative and qualitative study of alfalfa seeds.

Nineteen samples, grown and collected in 1909, from 11 different states, have been studied for two years.

On fresh seed the germ content varied from 16,000 to 12 per seed. With age the germ content decreases. A typical sample which when fresh had 7,780 per seed, when two years old gave 340 bacteria per seed.

Simultaneous platings were made from the 19 samples and representatives of each apparent group were determined according to the Society Card.

Of the 84 different group numbers determined, 35 were *Bacillus*, 21 *Bacterium*, 19 *Pseudomonas*, 1 *Streptococcus* and 8 Yeast. About one third of these forms were widely distributed and many of them very persistent on the seeds. Of the 84 groups, 68 were chromogenic, yellow being much the more common. The samples from semi-arid regions gave especially brilliant colors. But 8 of the 84 groups were spore formers and the spore formers represent only about one fifth of the forms present at the end of two years.

The reduction in numbers of bacteria, with age, is due to a decrease within each group, gradually the less numerous groups disappear. At the end of two years the most widely-distributed and most numerous group is *Bact.* 211.3332533—a non-spore former.

This work will appear as a bulletin of the New York Agricultural Experiment Station, Geneva, N. Y.

The Behavior of Pseudomonas radicolica in the Soil: B. M. DUGGAR and M. J. PRUCHA.

This paper is in the form of a preliminary report on (1) the effects of conditions, especially drying, on the vitality of the germ, and (2) the multiplication of the germ in soil under the influence of various factors. The results indicate that there are certain undetermined factors which seem to affect vitality after drying, yet it seems certain that after the rapid or sudden drying-out of soil cultures there remains a considerable number of living organisms, the existence of which may be determined either by the direct plate method, indirect plating (after inoculation into bouillon) or host inoculation. When soil cultures are directly and rapidly dried out the number of organisms found by the plate method may be no more than about one twentieth of those present when the drying began. This, however, relates to excessive drying. Where the drying process is less complete, the number remaining alive is much greater, and the life of the germ extends over a considerable period of time.

Cultures of this germ in sterile soil (clay loam) after five days gave about 160,000,000 organisms per gram, which is considerably more than the number found per c.c. in a control bouillon culture. In certain experiments, sterile and unsterile soils were mixed in various proportions, and the mixed material thoroughly inoculated and compared with the check in sterile soil. The addition of the unsterile soil inhibits multiplication of the legume germ as the amount of unsterile soil is increased.

Casein Media Adapted to Milk Analysis: S. HENRY AYERS.

CASEIN AGAR

Preparation of One Liter

Casein Solution	Agar Solution
300 c.c. distilled water	500 c.c. distilled water
10 gm. casein (Eimer and Amend c.p. casein prepared according to Hammersten)	10 gm. agar
7 c.c. normal sodium hydroxide.	
After dissolving casein make up to 500 cubic centimeters.	
<hr/>	
To 300 c.c. water (distilled) add	
10 gm. casein (Eimer and Amend c.p. casein prepared according to Hammersten)	
and 7 c.c. normal sodium hydroxide.	

Dissolve casein by heating to boiling. It is desirable to let this solution stand for several hours to get a perfect solution. This is not necessary, however. Make up volume to 500 c.c. and bring the reaction of the solution to between $+0.1$ and $+0.2$ Fuller's scale. Do not allow this solution to become alkaline to phenolphthalein or over -0.2 . If the casein is weighed accurately and the normal solution accurate the reaction will be about $+0.2$.

The agar solution is prepared by dissolving 10 gm. agar in 500 c.c. of water. Both casein and agar solution should be filtered, then mixed. Tube and sterilize in autoclave under pressure for 20 minutes; then cool the tubes quickly in cold water or ice water. The final reaction of the medium will be about $+0.1$ Fuller's scale. If the medium is alkaline, the bacterial growth will be restricted. If the medium is more than $+0.1$ some of the casein may be precipitated during sterilization. The casein agar should be clear and almost colorless when poured in a Petri dish. Sometimes the casein will be slightly precipitated during sterilization on the cooling, but it is of no consequence, since on pouring into plates the precipitate on account of its finely divided condition becomes invisible.

The study of the bacterial growth on casein agar and infusion agar shows the following points:

1. The 24 hours' count at 37° on casein agar was almost always lower than on infusion agar when raw milk is being examined. When pasteurized milk was examined the casein plates showed a higher count in 37 per cent. of the samples.

2. After 6 days' incubation at 30° C., out of 50 samples of raw milk plated, 44 per cent. of the samples showed higher counts on casein agar. With 50 samples of pasteurized milk, 78 per cent. of the samples showed a higher count on casein agar.

3. From a study of the bacteria from about 50 samples of both raw and pasteurized milk it seems that acid-forming bacteria do not develop quite as well on casein agar. It does, however, favor the growth of the alkali formers, the peptonizers and inert bacteria.

4. The number of peptonizing bacteria in a sample of milk may be determined directly from a casein agar plate. After counting the plate it should be flowed with $N/10$ lactic acid; this causes the precipitation of the casein, giving a white opaque plate except where the casein has been dissolved about a colony of peptonizing bacteria.

There is then left a clear zone around the colonies of peptonizing bacteria which enables one to determine their numbers in the sample of milk under examination. It has been found from a study of a large number of samples that this method of determination is accurate.

Sugars may be added to the casein agar or the casein solution may be used as a liquid medium without agar. It is believed that these media using casein will be of considerable value in bacteriological milk analysis.

The Analysis of the Gases Produced by One Hundred Cultures of Bacteria: WM. MANSFIELD CLARK.

The purpose of these analyses was to furnish data for the identification of gas-producing bacteria isolated from dairy products.

The bacteria were grown in a special form of culture bulb, evacuated with a mercury pump after inoculation, sealed up and incubated seven days at 30° C. The culture medium was a bouillon containing 1 per cent. dextrose. Exactly 5 c.c. of this was used in each bulb.

The collection of the gas was made with an Antropoff mercury pump and the analyses were made with special burettes and Hempel pipettes adapted for accurate analyses of small volumes.

The majority of the cultures analyzed gave a ratio of CO_2 , H_2 similar to that of *B. coli communis*. Certain other distinct ratios were found. These depend in large measure upon the volume of CO_2 , the hydrogen tending to remain constant. Certain other relationships are suggested tentatively, pending further investigation.

A Study of Gas-forming Bacteria in Milk: L. A. ROGERS and B. J. DAVIS.

Cultures of gas-forming organisms have been isolated from milk and other dairy products obtained in various parts of the country. These have been studied with special reference to the relation between certain physiological reactions, as the fermentation of carbohydrates and the amount of gas and ratio of H_2 to CO_2 . Plotted on the frequency basis the H_2 : CO_2 ratio has given four more or less distinct nodes, one at the ratio 1:1.1, one at 1:1.8, one at 1:2.2, and one at 1:2.7.

Arranged in a similar way, the amount of gas produced under given conditions shows nodes at 4 c.c., between 7 and 8 c.c. and 17 c.c.

Proper classification of the cultures shows a close correlation between the H_2 : CO_2 ratio and the amount of gas.

The gas ratio is further correlated in some cases with the fermentation of certain carbohydrates.

The group giving a ratio of 1:1.6 to 1:2.0 shows a distinctly greater ability to ferment saccharose, raffinose and starch than the group giving the ratio 1:1.1. It is probable that these tentative groups are somewhat heterogeneous and that further refinement by the use of new test substances will bring out sharper distinctions.

The Bacteriology of Cheddar Cheese: E. G. HASTINGS and ALICE C. EVANS.

Will appear soon in bulletin form jointly from the Dairy Division, Bureau of Animal Industry, U. S. Department of Agriculture, and the Wisconsin Experiment Station.

Some Actions of Microorganisms upon the Constituents of Butter: CHARLES W. BROWN.

For this work one lot of cream, divided into two parts—one part pasteurized at 160° to 170° F., the other not pasteurized—was churned and the butter placed in storage at -3° F. to +3° F. Of the 88 different species of microorganisms, not including molds or the higher bacteria, isolated from this butter 57 are bacteria (cocci, bacilli or spirilla) and 31 are yeasts. It was noticed:

1. That 24 of the bacteria and 15 of the yeasts will grow on 12 per cent. salt at 20° C. Four of these bacteria and six of these yeasts grow well on 12 per cent. salt at 6° C.

2. That the ratio of the number of species of liquefying bacteria to the number of non-liquefying bacteria isolated from ordinary agar is the same as the liquefying to the non-liquefying isolated from 12 per cent. salt agar.

3. That 12 per cent. of salt has a much more inhibitive action upon the species of liquefying yeasts than it does upon the non-liquefying.

4. That the lactose in both the pasteurized and unpasteurized butter decreased from 0.315 per cent. and 0.325 per cent. to 0.285 per cent. to 0.290 per cent., respectively, in 428 days.

5. That 50 per cent. of the decrease in lactose took place within the first 10 days.

6. That when the butter was taken from storage at the end of 428 days and placed at room temperature very little further decomposition of lactose occurred.

7. That the soluble nitrogen recorded in percentage of the total nitrogen in the butter increased in 428 days from 6.25 per cent. and 7.69 per cent. to 6.29 per cent. and 7.84 per cent. for the pasteurized and unpasteurized, respectively.

8. That the acidity of the pasteurized butter remained constant while that of the unpasteurized increased from 25.5° to 33.9° (Fuller's scale).

9. That when the growth upon synthetic agar was compared with the growth upon the same agar to which 1 per cent. butter fat—freed from impurities by melting and decanting—was added, 9 species of the bacteria showed a more luxuriant growth in the presence of fat, 11 were inhibited and 37 were indifferent; while 20 of the yeasts grew more luxuriant, 5 were inhibited and 6 indifferent.

A Bacteriological Study of the Milk Supply of Washington, D. C.: J. J. KINYOUN and L. V. DEITER.

A series of bacteriological examinations of the milk supply of Washington, D. C., were continued over a period of 14 months beginning in September, 1910, and ending on November 1, 1911. The objects of these examinations were to ascertain as near as was possible the actual conditions of the milk supply during this period so as to be able to formulate some means of its improvement.

Samples of milk were examined in accordance with the rules and methods prescribed by the Laboratory Section of the American Public Health Association and in addition thereto special methods were employed for the detection of the colon group.

The result of this study was that the milk supply of Washington was on the whole very unsatisfactory and was capable of a great improvement.

Nearly all the raw milk arriving in the city by rail had a very high bacterial content, the average for all samples for the 14 months was 9,300,000 and in no instance was it below 1,000,000.

55 per cent. of the samples contained both colon and streptococci. The close parallel between these two groups is looked upon by the writers as a sure indication of dirty collection and imperfect handling.

The examinations of the "pasteurized" milk as it is purveyed is far from satisfactory. This condition was due in a great measure to the imperfect way in which the process was applied, or to the attempts of the dealer to pasteurize an old or a dirty milk in order to sell it.

It has been clearly demonstrated by this study that a great amount of the milk as supplied is collected under unfavorable conditions, and is imperfectly or carelessly handled.

The Bacteriological Improvement of a Milk Supply by other than Laboratory Means: H. A. HARDING.

Bacterial studies have shown that the essentials for the production of cleaner milk are:

1. The utensils and the cow and her surroundings during the milking process must be as clean as possible.

2. The milk must be cooled as promptly and as thoroughly as possible. The problem of the bacteriologists becomes: how to induce the production of milk in accord with these essentials.

Attempts at securing this by establishing maximum permissible germ contents are undesirable because:

1. We lack data for establishing the point at which germ content begins to menace the public health.

2. We lack technique for determining the germ content of milk with an accuracy demanded by such legal enactment.

3. Such enactment has slight educational value because it can not be readily translated by dairymen into terms of their dairy practises.

The bacteriologists must translate the results of their studies into terms of dairy practises, and this translation may well take the form of a *score card*. If the valuation in this score card is correct the resulting score is an accurate measure of the relative desirability of the dairy product.

Such a mathematical expression is valuable because it facilitates buying and selling milk on the basis of quality.

In Geneva, N. Y., where the Cornell score card was taken voluntarily by the milkmen as a basis of payment according to quality:

"Poor" milk, originally one third of the total supply, decreased sharply and disappeared after three years.

"Medium" milk, originally about two thirds of the supply, decreased sharply and disappeared after three years.

"Good" milk, originally only five per cent. of the supply, quickly displaced the two lower grades.

"Excellent" milk, previously unknown, was twelve per cent. of the supply after three years.

The details of this work are given in New York Agricultural Experiment Station Bulletin 337.

This complete transformation of a municipal milk supply was accomplished at a cost to the city of \$500 per year.

The dairymen are desirous of furnishing the highest grade of milk for which they can get a price proportionate to the quality. The first necessity is a definition of the desired quality in terms which the dairymen can clearly understand. The dairy score card is the most promising attempt in this direction. The second necessity is the establishing of definite market grades of quality in milk, so that the consumer can purchase intelligently and create a commercial demand for a better article. The action of the New York Health Department in this direction is commendable.

Any permanent improvement in a municipal milk supply must rest upon conditions which make it more profitable to furnish a cleaner milk than to furnish a dirtier one.

The Principle of Vacuum Cleaning as Applied to Dairy Cows: G. L. RUEHLE.

The Object.—A comparison of the results obtained by a vacuum cleaner and by hand cleaning of cows. The points considered were (1) the effect on the germ content of the milk, (2) the time consumed.

The Method.—Two cows were cleaned each night by each method. The groups were alternated on succeeding nights. Observations were made on 22 nights.

The general average for hand cleaning was 669 per c.c., and for machine cleaning it was 1,145 per c.c.

Time Consumed.—Owing to the small number of cows per day, measurements of the time required by each method were not satisfactory. However, it was plain that the vacuum cleaning consumed more time than hand cleaning. As vacuum cleaning of cows took more time and gave poorer results, it does not commend itself to dairy practise.

EFFECT ON GERM CONTENT

	Germ Content per c.c. from Machine and Hand Cleaned Cows							
	Cow No. 1		Cow No. 2		Cow No. 3		Cow No. 4	
	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine
No. samples.....	10	12	10	12	11	11	11	11
Totals.....	20,765	26,459	1,479	1,624	2,541	16,309	3,305	8,297
Averages.....	2,077	2,205	148	35	231	1,483	300	754

Results will appear in a Bulletin of the New York Agricultural Experiment Station.

Suggestion of a New Method of Stating Composite Results of Bacterial Milk Counts: ERNEST C. LEVY.

Statement of the "average bacterial count" of milk samples in any city is of comparatively little value on account of the influence of a few samples, or even a single sample, of very high bacterial content.

The most approved method of statement of results has therefore been to give the number of samples, and the percentage of samples, falling in each of certain more or less arbitrary groups or classes, in the following manner:

(A) Class	No. of Samples	Per Cent. of All Classes
Under 10,000	25	16.7
10,001 to 50,000	73	48.6
50,001 to 100,000	37	24.7
100,001 to 250,000	9	6.0

If we apply this method to the hypothetical 150 samples given under (A) we get the following:

(C) Class	Rating Figure	No. of Samples in Each Class	Product
Under 10,000	100	25	2,500
10,001 to 50,000	90	73	6,570
50,001 to 100,000	75	37	2,775
100,001 to 250,000	50	9	450
250,001 to 499,000	20	3	60
Over 500,000	0	3	0
Totals		150	12,355
"Bacterial index"			82.4
250,001 to 500,000	3		2.0
Over 500,001	3		2.0
Total		150	100.0

This method, while of more real value than a mere statement of average count, is too cumbersome. In order to get around these difficulties, a new method of statement—the "bacterial index"—is suggested. To each of the groups above shown a rating value is given, as follows:

(B) Class	Suggested Rating Figure for Raw Milk
Under 10,000	100
10,001 to 50,000	90
50,001 to 100,000	75
100,001 to 250,000	50
250,001 to 499,000	20
Over 500,000	0

The bacterial index thus arrived at takes into account the number of samples falling in each class, but at the same time enables us to state our results in a single figure, and this figure is not unduly influenced by exceptional samples. The method itself is believed to be of real value, but the rating figures given are only suggestive and, if the method is adopted for general use, proper rating figures should be agreed upon after careful consideration by some competent body of bacteriologists.

In applying the method of statement to samples of pasteurized milk, a different set of rating figures should be used. We know less about this than about raw milk, but the following ratings are given as illustrative:

(D) Class	Suggested Rating Figure for Pasteurized Milk
Under 100	100
101 to 500	90
501 to 1,000	75
1,001 to 5,000	50
5,001 to 9,900	20
Over 10,000	0

An additional advantage of using the bacterial index in stating results for pasteurized milk samples is that we get around the danger of having misleading comparisons made between the bacterial counts of raw and pasteurized milk. Instead of this, with proper rating figures for each kind of milk, we can compare any group of raw samples with ideal raw milk and any group of pasteurized samples with ideal pasteurized milk.

The Control of Pasteurized Milk by Physical and Bacterial Standards: WILLIAM ROYAL STOKES and FRANK W. HACHTEL.

The article after emphasizing the importance of the control of the pasteurization of milk and of milk after it has been pasteurized described the bacterial reduction obtained through the pasteurization of milk by means of the so-called "slow" and "rapid" methods. It then mentioned the physical and bacteriological standards for the control of pasteurization which were established by Koehler and Tonney, of Chicago. The minimum temperature requirements for the continuous or rapid type of pasteurization are 160° F. (71° C.) for one minute, and for the slow or "holding" method 140° F. (60° C.) for twenty minutes. These requirements have been adopted

since the tubercle bacillus is destroyed under such conditions, and this is considered as a sanitary index of efficient pasteurization. As the bacteriological standard they require that there should be a reduction of 99 per cent. of the bacteria after pasteurization as compared to the raw milk, but this is not strictly applied if the bacteria are less than 100,000 per c.c. Koehler and Tonney have also shown the percentage of reduction during the various stages of pasteurization by the rapid method varying between 150° F. and 164° F., and by the slow method varying between 143° F. and 150° F. The bacterial count even in the bottled milk at the end of both processes showed a bacterial reduction of about 99.5 per cent., with the exception of the bottled milk in the rapid method, which only showed a reduction of 98.75 per cent.

This article, then citing the work of the authors, shows an average reduction by pasteurization in Baltimore of 99.4 per cent. by the rapid method and 99.1 per cent. by the slow method. There were fewer counts made of the rapid method (96) than by the slow method (146), and the counts of the raw milk by the rapid method were much higher.

The writers have also studied the percentage of cases in which the colon bacillus was present before and after pasteurization in 1 c.c. or in 1/10 c.c., and their results were as follows:

PERCENTAGE OF CASES IN WHICH COLON BACILLI WERE PRESENT BEFORE AND AFTER PASTEURIZATION

Rapid Method				Slow Method					
Number of Examinations	Colon Bacillus Present Before Pasteurization in 0.001 c.c.		Colon Bacillus Present After Pasteurization in 1 c.c.		Number of Examinations	Colon Bacillus Present Before Pasteurization in 0.001 c.c.		Colon Bacillus Present After Pasteurization in 1 c.c.	
96	45	46.8 %	48	50.0 %	146	86	58.9 %	87	59.5 %
Number of Examinations	Colon Bacillus Present Before Pasteurization in 0.001 c.c.		Colon Bacillus Present After Pasteurization in 0.1 c.c.		Number of Examinations	Colon Bacillus Present Before Pasteurization in 0.001 c.c.		Colon Bacillus Present After Pasteurization in 1 c.c.	
33	22	66.6 %	7	21.2 %	93	68	73.1 %	42	45.1%

The article then considers the recontamination of pasteurized milk, showing by the work of Koehler and Tonney that while the average count from a large number of freshly pasteurized milks was only 125,000, yet the average count from pasteurized milk one day old was 602,000 bacteria per cubic centimeter. Some of this milk showed counts varying between 1,000,000 and 4,800,000 per cubic centimeter. These authors think that this recontamination can best be obviated by a strict enforcement of a maximum standard for the temperature of milk of 50° C.

The conclusions are that the physical and bacterial standards of Koehler and Tonney are reasonable, and that the question of an additional safeguard establishing a maximum amount in which colon bacilli can be present in pasteurized milk is still open for debate.

Recent Developments in Pasteurization of Milk for a General Market: EDWIN HENRY SCHORER.

Pasteurization is employed legitimately to destroy pathogenic organisms of diseases transmitted through milk and to preserve milk so that it may be transported when properly refrigerated to localities where fresh milk is not obtainable. The process is used fraudulently to give low bacterial count to dirty milk, a redemption process, and to make milk keep in a manner similar to that of carefully obtained milk. In any event the process depends on heating milk to a temperature for a sufficient period of time to destroy the offending microorganisms. For fraudulent purposes it is only essential that a large percentage of bacteria be destroyed, while if milk is to be rendered free from possibility of causing infection, it is imperative that all pathogenic organisms be killed.

The entire process is based on scientific investigation, but unfortunately the results obtained in the laboratory are not obtained in the pasteurization of milk for the market. Pasteurization of

market milk must either be done in the bulk before bottling and capping or else in sealed bottles. Bulk pasteurization does not prevent reinfection and pasteurization in the bottle is expensive and time consuming.

While the primary object of the pasteurization of milk should be to destroy pathogenic bacteria, determination of the accomplishment of this object is a relatively difficult and slow process. For this reason the reduction in numbers of bacteria in milk is taken as evidence of efficiency of pasteurization. It is generally claimed that pasteuriza-

tion kills the lactic acid organisms and leaves the spores of peptonizing and putrefying bacteria. In the United States, however, pasteurized market milk coagulated sooner than does certified milk and peptonization occurs more frequently in the best grades of raw milk than in pasteurized market milk.

It can not be hoped that pasteurized dirty milk can be made as good as pasteurized clean milk, nor can a uniform product be expected as the result of pasteurization of market milk. While the higher grades of raw milk quite consistently have a low bacterial count, still they show a marked variation in flora. This same variation is observed in pasteurized market milk.

The technique in the laboratory does not prevail in the dairy and while pasteurization in sealed bottles can be made to represent laboratory methods, pressure for time may lead to over- or under-heating and shortening of the length of time of pasteurization. While heating to 140° F. for twenty minutes is sufficient in the laboratory to destroy pathogenic organisms, commercial conditions and mechanical devices are such that pasteurization should be carried on at a higher temperature and for a longer period of time.

The most efficient method of pasteurization is that under official supervision, controlling the quality of the milk pasteurized, pasteurization in the sealed bottle at 145° F. for thirty minutes, allowing at least thirty minutes to heat the milk to the pasteurizing temperature, and labeling such milk properly. This will insure sufficient temperature to destroy pathogenic bacteria, will inactivate the ferments but little, leave a good cream line and give a preferred milk.

The Bacterial Content of Oysters in the Shell in Storage: G. W. STILES.

Samples of oysters in the shell were taken from known localities during the months of November, 1910, and February, 1911, and placed in storage at a temperature of 39° F. Bacteriological analyses were made on five oysters constituting a single sample at various intervals ranging from one to 29 days. The usual technique for oyster work was observed for making the cultures. The oyster shells were well scrubbed in running tap water, their beaks briefly immersed in boiling water, and, with sterilized forceps and knife, the liquor removed from the shell into five sterilized petri dishes, one for the liquor of each oyster.

Definite quantities of 1 c.c., 0.1 c.c. and 0.01 c.c. from each oyster were planted into Durham fer-

mentation tubes containing lactose peptone ox bile. Dilutions of one to one hundred, one to one thousand, one to ten thousand, etc., were planted in duplicate on agar plates and incubated at 20° C., and 37° C., respectively, for three days.

The results obtained from the fermentation tests were expressed according to the suggested score of the Committee on Standard Methods of Shellfish Examination (*Journal of American Public Health Association*, Vol. I., No. 8, August, 1911).

Charts illustrating the *B. coli* content and the total bacterial count were exhibited. The results obtained varied, but not sufficiently to give positive indications as to results which may be obtained with samples stored at higher degrees of temperature. The variation of individual samples not in storage may, under certain circumstances, be as great as the results obtained on those kept in storage. Additional work on oysters showing greater degrees of pollutions and during different seasons of the year are contemplated before final publication.

Seasonal Variation in the Bacterial Content of Oysters: GEO. H. SMITH.

During the sanitary survey of Narragansett Bay, carried on during 1910-11, several facts were brought out regarding the bacterial content of oysters during different seasons. Frequent examinations of several layings were made during the period from December, 1910, to May, 1911, that is, during the coldest part of the year and during the period of the warming of the water. In these examinations the total count of organisms in the shell-juice of the oyster and the sea-water, the presence or absence of the colon bacillus in the oysters and the sea-water, the temperature of the water, etc., were noted.

An analysis of the data thus obtained seems to warrant the following statements:

During the colder winter months both the total number of organisms and the number of *B. coli* present in the oyster are very low as compared with that of the warmer weather.

The times when the total count and the colon count of the oysters are lowest are not the same, except within wide limits.

The period when the oysters contain the lowest total number of organisms or the fewest *B. coli* is not the period of lowest temperature.

The drop in total bacteria and in colon is apparently not related in any way to the decrease of organisms in the sea-water.

Thus it appears that the decrease in the bac-

terial content of the oyster is not directly dependent upon the number of organisms present in the sea-water, nor is it the direct effect of temperature, but is rather due to some cause lying within the oyster itself. Possibly during the colder months the oyster enters a state of hibernation, when no bacteria are taken in and those already within are gradually eliminated.

Variation in Acid Production of Colon Bacilli from Different Sources: WILLIAM W. BROWN.

During the sanitary survey of Narragansett Bay, Rhode Island, under the direction of Professor Gorham, oysters were taken from 242 stations to determine whether the distance of the oysters from the source of the pollution had any relation to the amount of acid the colon bacillus was able to produce in dextrose and lactose broths, with the hope of determining whether pollution was recent or remote. But the factors governing such an experiment as the tides, currents and winds were so variable that the author could only draw a comparison between the amount of acid produced by colon freshly isolated from feces and the colon isolated from oysters. Oysters were taken from 242 stations in the bay, some located in badly polluted areas, while some were taken from conditional zones (sometimes colon-positive, again colon-negative). In all cases the oysters were examined according to the standard methods of the committee of the Laboratory Section of the American Public Health Association. The fecal colon were isolated from the stools of Italian immigrants. The dextrose and lactose broths used in the experiment were made according to standard methods, except that meat extract was used in all cases.

Titration was made with N/20 sodium hydroxide into boiling solutions.

From the titrations it was noted that:

1. The optimum temperature for acid production by the colon bacillus is 37° C.
2. No matter how great the quantity of medium inoculated with the colon bacillus, the same per cent. of acidity is obtained.
3. More acid is produced in dextrose broth than in lactose broth by the colon bacillus.
4. The amount of sugar present in the medium has a direct relation to the amount of acid produced.
5. *Bacillus coli* freshly isolated from feces produces more acid in dextrose and lactose broth than *Bacillus coli* isolated from oysters.

Mutations in Microorganisms: D. H. BERGEY.

The success which seems to have attended the

attempts to produce mutation in some of the animal organisms, especially Trypanosomes, stimulated the hope that it would be possible to produce similar mutations in bacteria. In fact such mutations have been encountered, notably those described by Neisser, Massini and others. I have selected a typical colon bacillus, isolated from feces, as a desirable organism with which to attempt to produce mutation forms. The success which Altmann and his associates had in changing the immunity reactions of the colon bacillus, suggested that it might be possible to change some of its other characteristics. With this object in view, I exposed the colon bacillus to various organic and inorganic substances, added to ordinary bouillon for varying periods of time. I then tested these organisms as to their general biological characters and the immunity reactions. Among the substances to which the culture was exposed were copper sulphate, chloroform, picric acid, resorcinol and horse serum. Thus far none of the biological characters of the organism have been altered—either increased or decreased to any appreciable degree. The immunity reaction, especially the agglutination reaction, appears to show evidences of alteration. These alterations are most marked in the race exposed to horse serum, though all of the chemicals employed seem to so change the organism as to inhibit agglutination altogether or permit its manifestation only in serum of high agglutinative power. The alterations in the characters of the organism are insufficient in degree to warrant one in classifying them as mutations.

The Antiseptic and Bactericidal Properties of Egg-white: LEO F. RETTGER and JOEL A. SPERRY.

Normal egg-white possesses marked antiseptic and bactericidal properties towards certain bacteria, particularly the members of the *subtilis* group. *B. subtilis* and *B. megatherium* were destroyed almost instantaneously when introduced into test tubes containing the whites of hens' eggs. Certain strains of *B. coli* and *B. typhi* were quite susceptible, while others were but slightly affected. The same thing was found to be true of *B. pulchrum* (Rettger). With respect to the last-mentioned organism the degree of resistance bore a definite relationship to the virulence, the more virulent strains showing the greater resistance to the action of the egg-white.

Proteus Zenkeri was quickly destroyed, while *Proteus vulgaris* was less rapidly influenced and *Proteus mirabilis* suffered but little, if any.

Staphylococcus pyogenes aureus and *B. fluorescens* were very quickly affected. *Bacillus putrificus* (Bienstock) and *B. edematis maligni* were unable to develop and bring about any putrefactive changes whatever in the white of egg, while the yolk and the coagulated egg-meat medium rapidly underwent putrefaction.

Heating at 65-70° C. for 15 minutes destroys the antiseptic and bactericidal properties of egg-white.

The Effect of Certain Antiseptics upon Staphylococcus pyogenes var. aureus: T. D. BECKWITH, T. D. BRANDENBERG, J. DINWIDDIE and C. H. HOFSTRAND.

In order to learn the efficiency of certain antiseptics commonly used in veterinary practise the following work was carried out under test-tube conditions.

The antiseptic was added to distilled water with the proper dilution and a loopful of a twenty-four hour culture in broth of *Staphylococcus pyogenes var. aureus* isolated about one week previously from a case of empyema was then mixed with the antiseptic solution. Plates were poured, using standard beef agar after intervals of one, five and twenty minutes, all results being obtained in duplicate. The following seventeen compounds and preparations were used: alcohol, pyoktanin blue, pyoktanin yellow, Lugol's solution, potassium permanganate, cresol, liq. cresolis comp., boric acid, lysol, formaldehyde, hydrogen peroxide, silver nitrate, mercuric chloride, phenol, "Benetol," "Creolin," "Septico," the last three being preparations on the market.

Following appeared to be the order of efficiency, beginning with the most active: silver nitrate, mercuric chloride, Lugol's solution, pyoktanin blue, potassium permanganate, pyoktanin yellow, liq. cresolis comp., cresol, "Benetol," "Creolin," formaldehyde, lysol, "Septico," hydrogen peroxide, phenol, boric acid, alcohol.

Check tubes and counts were made at frequent intervals.

Aggressin Immunization Against Symptomatic Anthrax: OTTO W. SCHÖBL.

Briefly, the results of the experiments are as follows:

1. The existence of aggressin in black leg edema has been proved, since the sterile edema fluid aids infection by hindering the natural protective apparatus of the organism. Phagocytosis chiefly is inhibited.

2. It is non-toxic even in much larger quantities

than the amount necessary to change a sublethal dose of symptomatic anthrax bacilli into the lethal dose.

3. Repeated injections of sterile edema fluid leads to a considerable degree of immunity. The animals are not only immune themselves, but also yield serum that protects normal animals from subsequent infection.

4. Such a serum shows the presence of antibodies demonstrable both in vitro and in vivo, the most striking characteristic being its favorable effect upon the phenomenon of phagocytosis.

5. In the subcutaneous circumscribed infiltration following artificial infection, immunized animals may under certain circumstances harbor virulent symptomatic anthrax bacilli.

Therefore, the immunity can not be considered bacteriolytic.

6. The immunity consists of a complete or partial inhibition of the growth of symptomatic anthrax bacilli in the body of the immunized animal. If the immunity is not sufficient to suppress completely the growth of bacilli, they multiply locally and are still able to produce toxin. The difference between antitoxic and anti-infectious immunity is in the case of symptomatic anthrax quite evident.

7. The fact frequently observed in our experiments that immune animals may harbor in their bodies symptomatic anthrax bacilli, fully virulent for normal animals, is worthy of consideration from an epidemiological standpoint.

8. The method of immunization with aggressin is advantageous in that the inoculating material is a sterile fluid, hence the danger of making bacillus-carriers or setting up a virulent infection through the vaccinating material is avoided.

The Role of Homologous Cultures in the Production of Immunity in Rabbits to Fowl Cholera: PHILIP B. HADLEY.

The present paper describes certain aspects of an immunity artificially produced in rabbits against infection with a very virulent culture of the fowl cholera organism. This was accomplished by means of a subcutaneous inoculation with a small amount of a nearly virulent, homologous culture of the cholera bacterium. The following points are made clear:

1. Of ten different strains of the fowl cholera organism employed, only one (Culture 52) was capable of producing immunity to a highly virulent culture.

2. The smallest amount of Culture 52 found to produce immunity was 0.000,000,01 c.c., but

amounts as large as 3 c.c. were easily tolerated and gave similar results.

3. In protectively inoculated rabbits a slight resistance was manifested within 3 to 4 days, but complete immunity did not appear until the seventh day after the protective inoculation.

4. That the resistance in question was not a "zonal" or local immunity was shown by inoculation of previously protected rabbits in the ear, flank and back; also by intravenous and intraperitoneal inoculations, none of which were fatal.

5. The resistance produced by inoculation with 2 c.c. of Culture 52 was sufficient to protect against at least 3 c.c. of the virulent culture when the M.L.D. of the latter was one hundred-quintillionth (0.000,000,000,000,000,001 c.c.) of one cubic centimeter.

6. Both fowls and pigeons have been rendered immune by inoculation with Culture 52. But, whereas a single inoculation is invariably sufficient for rabbits, fowls and pigeons may require two.

7. Attempts to produce resistance by inoculation with killed and attenuated cultures have failed; likewise attempts to produce resistance by successive inoculation with gradually increasing numbers of living organisms; this last is probably due to the fact that inoculation with even 4 organisms is fatal.

8. In rabbits, immunity to the virulent culture has been found to endure for at least 8 months.

9. The immunity obtained through inoculation with Culture 52 is inherited; female rabbits, six and one half months after the protective inoculation, are able to give birth to young which are perfectly immune.

10. The blood serum from resistant rabbits is protective.

Serum Diagnosis of Glanders: JOHN R. MOHLER.

In 1909 Schütz and Schubert published the results of their important work on the application of the method of complement fixation for the diagnosis of glanders. Their experiments were followed by splendid results, exceeding by far those obtained by either the mallein or agglutination test. Consequently, they recommended that this method of diagnosis in combination with the agglutination test be taken as the official test in Germany. This method, overcoming as it does the disadvantages of the mallein and agglutination tests, constitutes the most reliable method for the diagnosis of glanders which we have at our command at the present time. It has recently been thoroughly studied by the Bureau of Animal

Industry and has proved to be highly satisfactory. The principle of this test is presented in the phenomenon of hemolysis, which was first discovered and studied by Bordet and Gengou. This phenomenon consists of the well-known fact that if red blood cells of one animal are introduced into another of a different species, the blood of the latter acquires the power to dissolve the blood cells of the former when mixed with them in a test tube. The substances necessary for hemolysis are, (1) the hemolytic amoceptor, which is the serum of a rabbit that has been injected with washed sheep corpuscles; (2) the complement in the form of normal guinea-pig serum, and (3) washed blood corpuscles of the sheep. In the complement fixation test there are also used, besides the hemolytic system, the serum of the horse to be examined and an extract of glanders bacilli, termed antigen.

The complement fixation test is so called on account of the fact that the complement is fixed by the combination of glanders bacilli extract with antibodies in the serum of a glandered horse, and is thus prevented from participating in the hemolytic process in which it is essential in order for hemolysis to take place. By this method, even small quantities of glanders antibodies (amoceptors) can be demonstrated in a serum.

The complement fixation accordingly represents a specific test, as only in the presence of glanders antibodies and glanders antigen will a reaction take place. The results of the test should be interpreted as follows:

1. Horses in which the serum produces a complete fixation of the complement in quantities of 0.1 c.c. and 0.2 c.c. should be considered as glandered.

2. Horses in which the serum gives a complete fixation in the quantity of 0.2 c.c., and an incomplete fixation in the quantity of 0.1 c.c., should likewise be considered as glandered.

3. Horses in which the serum produces incomplete fixation in quantities of 0.1 c.c. and 0.2 c.c. should also be considered as glandered.

4. Horses in which the serum shows no fixation of the complement should be considered free from glanders.

In order to reduce the possibility of error to a minimum, the agglutination test may be applied to the negative cases, and if this shows a value of 1:1,000 or over the animal should be considered as glandered. However, such cases are extremely rare.

The Effects of Subdural Injections of Leucocytes on the Development and Course of Experimental Tuberculous Meningitis: WILFRED H. MANWARING.

The injection of suspensions of tubercle bacilli into the basal meninges of dogs causes a tuberculous meningitis, characterized by a latent or incubation period of from five to thirty days, depending on the dosage and virulence of the culture injected, followed by a period of increasing paralysis and incoordination, ending almost invariably in death.

The injection of homologous leucocytes into the basal meninges of these animals, during the latent or incubation period of the disease, has the uniform effect of delaying the development of the paralytic symptoms. In dogs injected with small doses of tubercle bacilli of low virulence, the development of the paralytic symptoms has been prevented by this means for a period of seven months (up to the present time), while the untreated control animals, injected with the same doses, have all developed paralyzes within a period of about four weeks, from which half of the untreated dogs have thus far died.

In press, *Journal of Experimental Medicine*, 1912.

Simple Methods in the Bacteriological Diagnosis of Cholera: CHARLES KRUMWIEDE.

Two points were kept in view, viz., the possibility of examining enormous numbers of cases with the minimum of equipment and the rapid preparation of media for immediate use in emergency.

In general, no medium is necessary but peptone water. If the feces contain a sufficient number of cholera vibrios, the peptone cultures after eight to twelve hours have practically a pure culture at their surface. If a drop of this and immune serum be mixed, the microscopic agglutination is so prompt and evident as to be diagnostic.

In examining carriers or mild cases the first peptone tubes may show little or nothing. If, however, some of the surface growth be subinoculated in a second series of peptone tubes and incubated, the surface growth becomes sufficiently pure for testing the agglutinability of the vibrios.

In four instances we have been unable to make a diagnosis till the end of the second enrichment.

Vibrios other than cholera can be excluded by their inability to enrich or by the absence of any influence of the agglutinating serum. Where they are few in number, as for instance in the first

enrichment, a tentative diagnosis can be made by the influence of the serum on their motility. The motility of cholera and the very closely allied vibrios is so marked as to be evident even in mixed cultures.

We were able by this method to diagnose two carriers among the passengers of one ship, 50 per cent. of whom had cholera-like vibrios in their stools. The results were all verified by the use of the Dieudonne medium.

A Simple Selective Medium.—We have tried to avoid the use of defibrinated blood, which is not always obtainable in emergency. The following formula, substituting eggs, gives equally favorable results:

- | | |
|--|---|
| A. Whole egg and water a.a. | } Mix in equal parts, steam for 20 min. |
| Sodium carbonate (crystalline, 12 to 13½ per cent.) | |
| B. Meat free agar, viz., peptone, salt and 3 per cent. agar. | |

Mix A, 30 parts, and B, 70 parts, while the agar is boiling hot. Pour medium to thick plates, allow them to stand open for 20 minutes to dry and then inoculate by surface streaking.

Should other fecal bacteria grow, the cholera colonies can easily be selected. The latter have a distinctive hazy outline and appear to be deep in the agar. With longer incubation a zone of clearing appears about the colonies.

Studies on Etiology of Equine Influenza: N. S. FERRY.

A *Streptococcus*, presumably the organism described by Schültz and others, has been cultivated uncontaminated from the trachea in the early stages of nearly every case of acute influenza studied.

An organism with the same characteristics has been isolated from the blood of thirty-four out of sixty-three cases.

Symbiotic relationship with the *Staphylococcus*, in broth cultures, seems to favor the growth of this *Streptococcus*.

This organism was able to pass many times through Berkefeld filters, and a few times through Chamberland filters, showing that it is a very minute organism in some stage of its life cycle.

The *Bacillus equisepticus* has not been seen in, nor isolated from, either the trachea or blood of a single case of influenza, therefore, Lingnieres's findings have not been corroborated.

We have not been able to find any points of difference between this organism and the *Strepto-*

coccus isolated from the abscesses in the cases of strangles.

Inoculation experiments were not extensive enough to warrant any conclusions as to the infectious nature of the organisms. We have record, however, of one case with the fever, prostration, cough and discharge from the nostrils, which was very characteristic of influenza. This followed the intravenous injection of a pure culture of the organism. We had another case of a large tumor at the site of inoculation after a subcutaneous injection of the same culture.

From the light of our work, up to the present time, we do not feel justified in stating positively that this *Streptococcus* is the cause of influenza in horses, but we do believe that the findings point very strongly to that conclusion.

If this proves to be the same organism that is found in strangles and also contagious pneumonia, and it is agreed by all authorities that the *Streptococcus* found in strangles is the cause of that disease, then, we believe, we are justified in putting forward the argument that this *Streptococcus* is the cause of the symptom complex we have termed "influenza," and that strangles and contagious pneumonia are not clinical entities, but complications of influenza due either to secondary infections or to extension of the primary disease.

The Influence of the Carrier in the Management of Institutional Diphtheria: J. J. KINYOON.

The writer reports that since 1908 it has been the custom of the Health Department when a clinical case of diphtheria is reported from any institution to make an examination of all the contacts. Since beginning this there have been reported 23 clinical cases of diphtheria from 14 institutions. Cultures taken from all the contacts, immediate or remote, gave 220 carriers out of 2,004 contacts. In all the institutions save one there were no further cases. In one over which the Health Department acted only in an advisory capacity, and where there was not a complete culturing of all the contacts, other clinical cases did occur. Such cases did not cease until all the contacts were cultured. All bacillus carriers are considered as if they were clinical cases and are subjected to the same quarantine methods.

The writer finds that there is no arbitrary rule for the discharge of the carrier from quarantine, but must be done on the culture test. An analysis of the 199 cases of the carrier shows that the first negative culture from these was as follows: 20 cases on the 3d day; 18 on the 4th day; 30 on the

5th day; 34 on the 6th day; 30 on the 7th day; 22 on the 8th day; 10 on the 9th day; 2 on the 10th day; 5 on the 11th day; 10 on the 12th day; 9 on the 13th day; 3 on the 14th day; 3 on the 16th day; 2 on the 18th day; 1 on the 30th day. In none of these carrier cases were there any clinical symptoms.

The writer agrees with McDonald that the control of diphtheria is the control of the carrier.

A Panum Incubator with Important Modifications: LEO F. RETTGER.

In the construction of an incubator designed to meet the general needs of a bacteriological laboratory, the Panum model as described in Klöcker's "Fermentation Organisms" was chosen. The construction work was entrusted to a skilled copper-smith in New Haven. Copper was used throughout, except in the hinges of the doors, which are of brass, and the outer wall of the incubator, which was made of one-inch wood. Three inches of felt were packed between the outer and inner walls. Instead of being provided with four large outer doors which are fastened by hinges on the floor of the incubator, the incubator has eight doors, two for each main, square, compartment. The doors are in pairs, they swing on hinges and close in such a way that one door fits closely against the other. The doors are about three inches thick, and at the same time light in weight, as the space within the two walls is filled with air. Each of the eight compartments, excluding the refrigerator, is further provided with a glass door, which is easily removed. A gas safety lamp is the source of heat for the blood temperature end of the incubator. The compartment which is heated directly by the flame is surrounded completely with water. The water jacket is connected with a small water container which is made of copper. As the gas pressure is fairly uniform, this arrangement has given entire satisfaction. A Reichert thermo-regulator is installed.

When the refrigerator end is kept well supplied with ice the incubator is remarkably efficient. The temperatures in the different compartments are practically constant. This has been demonstrated particularly in a long series of experiments in which frequent and painstaking determinations were made.

All abstracts have been supplied by authors unless otherwise stated.

CHARLES E. MARSHALL,
Secretary

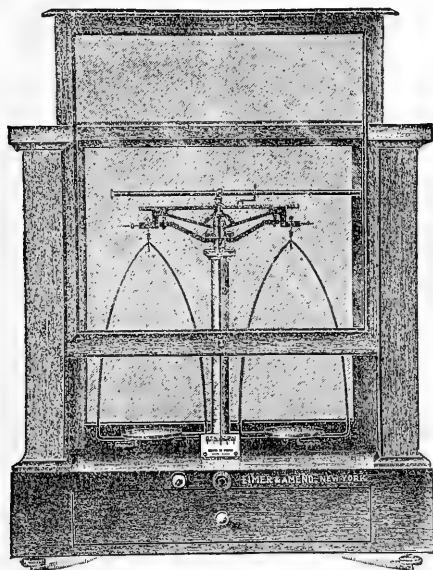
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THE GLACIERS AND GLACIATION OF ALASKA¹

INTRODUCTION

NOTWITHSTANDING the great area of Alaska, the ruggedness and inaccessibility of a large part of the glaciated region, and the briefness of the period of exploration, we are already in possession of a large body of fact with regard to the glaciers and glaciation of our northern territory. The researches of Wright,² Russell,³ Reid,⁴ Gilbert,⁵ Davidson,⁶ Dall⁷ and others have given us much valuable information concerning the coastal region; and the many expeditions by Hayes,⁸ Brooks, and various other members of the United States Geological Survey⁹ have added ma-

¹ Presidential address before the Association of American Geographers, at the Washington meeting, December 29, 1911.

² Wright, G. F., "The Ice Age in North America," New York, 1891, chapter III., pp. 36-66.

³ Russell, I. C., "An Expedition to Mount St. Elias, Alaska," *Nat. Geog. Mag.*, Vol. 3, 1891, pp. 53-203; "Second Expedition to Mount St. Elias," Thirteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1892, pp. 1-91.

⁴ Reid, H. F., "Studies of Muir Glacier, Alaska," *Nat. Geog. Mag.*, Vol. 4, 1892, pp. 19-84; "Glacier Bay and its Glaciers," Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1894-95, pp. 415-461.

⁵ Gilbert, G. K., "Glaciers and Glaciation," Harriman Alaska Expedition, Vol. III., New York, 1904.

⁶ Davidson, G., "The Glaciers of Alaska," *Trans. and Proc. Geog. Soc. Pacific*, Vol. III., Ser. II., June, 1904, 98 pp.

⁷ Dall, W. H., U. S. Coast Pilot, Pacific Coast, Part I., Alaska, 1883, Washington, D. C.

⁸ "An Expedition through the Yukon District," *Nat. Geog. Mag.*, Vol. 4, 1892, pp. 117-159.

⁹ Mainly published in annual reports, bulletins and professional papers of the U. S. Geological Survey.

terially to this knowledge, and have extended the area of observation to the interior. Thus, even though there is yet much to learn, the knowledge that we now possess is sufficient to warrant a discussion of the general phenomena of Alaskan glaciation; and since this is the object that has been most in my mind during the past six years, it has naturally appealed to me as the most fitting topic for the presidential address which I am called upon to give.¹⁰

THE EXISTING GLACIERS

Condition of the Existing Glaciers

Alaskan glaciation is, and has been, of the mountain type. That is to say, mountain snow fields have shed into mountain valleys, and through these the glacier ice has flowed to lower levels, in some cases even to the sea. Numerous glaciers, and in former times a still greater number, have flowed beyond their valleys and spread out fan-shaped at the mountain base, giving rise to the type of *pedmont* glacier which Russell has made known to us through his studies of the Malaspina glacier.

The main region of existing glaciers occupies a roughly semicircular area sweeping from the southern boundary of Alaska, northward, westward and southwestward,

¹⁰ The personal field work upon which this address is in part based was done in 1905 and 1906 under the auspices of the U. S. Geological Society; and in 1909 and 1911 under the auspices of the Research Committee of the National Geographic Society. To both of these bodies acknowledgments are due for the generous financial support given. The last two expeditions have been under the joint leadership of Professor Lawrence Martin and myself; and I wish especially to acknowledge my indebtedness to my colleague in two seasons of work, who was also an assistant on the first expedition. We have worked and observed together and have freely discussed all problems which have arisen. The results of our joint work are used in this address, as are also the results of other students of Alaskan glaciation.

toward the Aleutian islands. From either end of this zone both the number and the size of the glaciers increase, and the elevation of their termini decreases, attaining maximum development near the center of the semicircle that surrounds the head of the Gulf of Alaska. Altogether there are at least 47 tidal glaciers in this zone, the southeasternmost being the Le Conte Glacier, just north of Wrangell, and the westernmost McCarty Glacier on Kenai peninsula. Toward the ends of the glacier zone there are few and scattered instances of tidal glaciers; but in the central part of the zone they are numerous, and, where topographic conditions favor, are close together. Thus in Glacier Bay there are at least twelve tidal glaciers; in Yakutat Bay three; and in Prince William Sound twenty.

How many glaciers there are in this coastal area can not be even approximately estimated; but, counting large and small, tributaries and main ice streams, they are certainly to be numbered by the thousand. These vary in size from tiny ice masses in cirques, to valley glaciers two or three miles in breadth and thirty or forty miles in length; and up to the great Malaspina Glacier whose area is estimated to be 1,500 square miles. From the Kenai peninsula to Cross Sound a very large proportion of the seaward face of the mountains is covered with snow and ice, and glaciers exist in a majority of the valleys, deeply filling most of the larger ones. From Controller Bay to Cross Sound a succession of piedmont glaciers and expanded bulbs of individual glaciers spread out between the mountain base and the sea. A journey along this coast is, therefore, a constant glacial panorama.

Distribution of Existing Glaciers

The mountains which fringe the Alaskan coast as a continuous barrier, as far west

as Cook Inlet, attain their greatest elevation in the St. Elias-Fairweather Range where peaks rise 12,000 to 15,000 feet, 18,000 feet in Mount St. Elias, and 19,540 feet in Mount Logan. Here, naturally, the glaciers are largest, for from this central area the general elevation, as well as the heights of the peaks, diminishes toward both the southeast and the west.

Back from the coast, and roughly parallel to the curving mountain barrier around the head of the Gulf of Alaska, is another lofty range sweeping northward from the Alaska peninsula, then eastward and southeastward. In its highest part, called the Alaska Range, are numerous lofty mountain peaks, including Mount McKinley (20,300 feet), the highest mountain in North America. Between this interior range and the coastal mountains is a broad depression occupied by Cook Inlet in the south and the Copper River Basin in the east; but in the extreme east the area between the two mountain ranges is mainly occupied by the great volcanic group known as the Wrangell mountains, whose peaks attain elevations of from 14,000 to 16,000 feet.

Naturally these lofty mountains of the interior are also the seat of numerous and large glaciers. But neither here, nor on the inner face of the coastal mountains, is there so full a development of ice and snow as along the coast. The snow line is higher, the glacier ends are all necessarily well above sea level, and the piedmont type of glacier is absent. The glaciers are essentially confined to the mountain valleys, though some extend to the mouths of the valleys, and a few spread slightly beyond them. It must not be inferred that the glaciers of the interior are insignificant either in size or in number; merely that they suffer in comparison with their larger neighbors nearer the sea. Were

they the only glaciers of Alaska they would themselves attract wide attention because of their number and size. Besides being dwarfed by comparison with the coastal glaciers, these in the interior have the disadvantage of remoteness and relative inaccessibility. They are, therefore, far less well known than the glaciers of the coast.

The difference between the glaciers on the two sides of the coastal mountains may be typically illustrated by the Valdez-Klutena system, two glaciers which descend in opposite directions from a common divide in the Chugach mountains, at an elevation of 4,800 feet. The Valdez Glacier, descending on the seaward side of the mountains, is 19 miles long and ends at an elevation of 210 feet, while the Klutena Glacier, descending toward the interior, is only 6 miles long and ends at an elevation of 2,000 feet. A similar difference is observed in the Nizina and Chisana glaciers, which descend from a common divide at an elevation of 8,000 feet in the Wrangell Mountains, the former descending on the side facing the sea and therefore being much longer than the Chisana Glacier, which flows toward the interior. The total length of the two ice streams is about 47 miles.

Beyond the Alaska Range, although there are numerous mountain and plateau areas of considerable elevation, lying far to the north, there is a general absence of existing glaciers, the only exception, so far as known, being on the Arctic slope of the Endicott Mountains (5,000-8,000 feet). Here, in the summer of 1911, Phillip S. Smith and A. C. Maddren¹¹ observed a number of small valley glaciers.

Explanation of the Distribution of the Glaciers

The distribution of glaciers in Alaska is not difficult to explain. That they are so

¹¹ Personal communications to the author.

extensively developed along the seaward face of the coastal ranges is plainly due to the fact that the prevailing winds are from the ocean, and that in blowing over the warmed waters of the Gulf of Alaska a large amount of vapor is moved forward and precipitated in the form of snow upon the lofty mountain barrier. It is where the coastal barrier is most complete and highest that the snowfall is heaviest and the development of glaciers greatest. The annual precipitation varies greatly, records of from 100 to 190 inches having been obtained at stations along this coast; but there is no knowledge as to the precipitation among the lofty mountains, excepting the knowledge that it is very heavy and mainly in the form of snow.

In a region where from 10 to 40 feet of snow falls each year at sea level, there must be exceedingly heavy snowfall at elevations where the precipitation is all in the form of snow. As an indication of the vast snowfall among the mountains, reference may be made to Schrader's observation of from 8 to 12 feet of snowfall on Valdez Glacier during a week late in April and early in May, 1898. By such heavy precipitation the snowline is depressed to levels of 2,500 to 3,500 feet on the seaward face of the mountains, and to even lower levels back in the mountains where the local climate is cooled by the chill of the surrounding areas of snow and ice.

Since the damp winds precipitate so much vapor in crossing the mountain barrier, there is a deficiency for precipitation on the inner slopes of the mountains and on the ranges further inland. Moreover, such winds as sweep into interior Alaska from either the Arctic Ocean or Bering Sea bear but a limited vapor burden, since the water of these seas is cold in summer and more or less completely ice-covered in winter. Records at Eagle give a rainfall of only

11.35 inches; but the precipitation is doubtless higher toward the west and in the lofty mountains.

The winters of the interior are prevailingly clear and cold with moderate snowfall—for example, only 2 or 3 feet of snow falls in the Copper River Basin; but in spring and summer the temperature is so high that the snow quickly melts even well up on the mountain slopes. Thus, even in the neighborhood of the Arctic Circle a plateau from 3,000 to 6,000 feet in elevation is completely free from snow in summer, as is also a large portion of the Endicott mountains; and, whereas the snowline on the seaward face of the St. Elias range is about 3,000 feet, it is more than twice as high as that in the interior three or four hundred miles further north. The exact elevation of the snowline in the interior can not be stated, and indeed it must vary greatly from place to place. In general, however, it is above 6,000 feet.¹²

This rise in the snowline toward the north is interesting as showing how important the element of precipitation is. The snowline is lower and the glaciers are larger where the mean annual temperature is high and the precipitation is heavy, than in the much colder climate further north where, however, precipitation is light and the short summers are warm. A similar variation is noticed in the coastal mountains where the snowline is considerably higher along the inner fiords than on the outer coast where the precipitation is heavier. It is to be noted, however, that in the latter place not only is there a greater depth of snow to be melted, but in the neighboring lofty mountains there are

¹² Oscar Rohn (Twenty-first Annual Report U. S. Geological Survey, pt. 2, 1899-1900, p. 413) states that on September 1 the snowline was 7,500 feet in one part of the Wrangell Mountains, and was then descending.

broad expanses of snow and ice which serve to retard summer melting.

In the distribution of its glaciers Alaska presents a striking contrast to that part of Europe in the same latitude. There are no glaciers in southern Scandinavia, in the latitude where, in Alaska, the glaciers are largest; and while in Norway there is an increase in glaciation northward, in Alaska there is a decrease. In Norway the influence of latitude is permitted to exert its normal effect; but in Alaska the influence of latitude is effectually counterbalanced by variations in topography and in the vapor content of the air. This contrast may have some significance in the explanation of the development of extensive ice sheets in northwestern Europe and northeastern America, while northern Asia and northwestern North America, in the same latitude, were free from continental glaciation.

Ice Flooded Valleys and Through Glacier Systems

Only by individual description of a large series of instances would it be possible to adequately portray the varied characteristics of the Alaskan glaciers. As in the Alps, Caucasus and Himalayas, the valley glacier is the normal type, but with many variations in form, size and rate of motion. From the lofty peaks a series of radiating glaciers usually spread outward; but throughout much of the mountain area there is a complex of ramifying glacier systems. Nowhere, so far as known, is there a development of the ice cap condition such as is found in Norway, Spitzbergen and Iceland, for the mountains are so lofty and rugged that the valley slopes serve to drain away the surplus snow that falls upon the steep mountainsides.

Still the snowfall is so heavy, especially near the coast, that, in the process of

drainage, the valley systems are deeply filled with ice in spite of the ruggedness and high elevation. In the area of greatest glacier development, in the St. Elias region, the extent of snow and ice is so great as to have led Russell to speak of it as "a vast snow-covered region, limitless in expanse, through which hundreds and perhaps thousands of barren, angular mountain peaks projected," and to compare it to the "borders of the great Greenland ice sheet." How deeply these vast glacier systems fill the valleys we have no means of telling; nor can we even estimate the aggregate length or area of the maze of ice streams that flood the mountain valleys. In a region where dozens of glaciers are known to have lengths of from twenty-five to forty miles, it can not be doubted that the aggregate length of the ice streams is thousands of miles, and that the total area of snow and ice amounts to tens of thousands of square miles.

Although the vast bulk of ice that is slowly draining away the snow that falls among the Alaskan mountains maintains the valley glacier condition rather than developing an ice cap, it gives rise to an intermediate condition, as Russell's description intimates. That is, although the mountain summits are not flooded, the valleys are. For example, one may start from Yakutat Bay and, traveling up one of the large glaciers, rise above the snowline by a moderate grade and finally reach a flat, snow-covered divide, beyond which, also with moderate grade, a descent leads down a glacier flowing in the opposite direction. Or, to the right or the left, also over flat, snow-covered divides, an easy route is open down other glaciers. In this way one may travel for scores of miles, going from one valley to another and from one glacier to another, but crossing only broad, flat snow divides. So deeply is the region submerged

by ice that both the valley bottom topography and the valley head divides are so smoothed out as to give rise to a continuous, connected glacier system with drainage in different directions from flattish divides; but both the divides and the glacier distributaries from them are walled in by steeply rising mountains, each portion of the system having the characteristics of the valley glacier. For such a complex I have proposed the name—*through glacier system*.

The through glacier condition is rendered possible by presence of low divides, and it is believed that, in general, these have originated during an earlier period of more intense glaciation when the snow and ice accumulated to much greater depths than now and flowed across the divides, lowering them by glacial erosion.

In its main essential characteristics, even the through glacier system belongs in the class of valley glaciers; and the valley glacier phenomena in Alaska are in the main the same as those with which we are already thoroughly familiar from the studies of glaciers in the Alps, Himalayas and other mountain regions. As compared with those of the Alps, the larger valley glaciers of Alaska are far greater, and this naturally introduces corresponding differences in form and behavior; but these are differences in detail rather than in underlying principles, and may therefore be dismissed in the present discussion.

At their termini some of the Alaskan glaciers present features not found in the Alps, notably the termination in tidal cliffs from which icebergs are discharged, and expansion on the land to form piedmont bulbs and piedmont glaciers. At a period of former expansion of glaciers, the piedmont condition was present in the Alps also; and the present Alaskan glaciers are more comparable with those expanded

Alpine glaciers than with their shrunken descendants of to-day.

Development of the Cascading Glacier

As in other mountain regions, the present-day Alaskan glaciers, though very large, are mere remnants of a former far greater system, occupying the lower levels of valleys which were profoundly deepened by erosion when the former greater ice masses occupied them. Accordingly, the surface of the present-day glaciers, in the main valleys, is very often well below the level of the surface of the tributaries, which therefore descend with steep slope at their lower ends. There is every gradation, from the accordant junction of tributary and main glaciers, to the ice step, or "bench," where the two join; to the cascading descent of the tributary as it joins the main ice stream; and to the former tributary, now cut off from junction with the main glacier, but cascading toward it in its lower portion where it passes out of its hanging valley and descends the steepened valley slopes in a series of broken steps like a great frozen waterfall. This condition is so well developed in Alaska, and is so widespread and so characteristic, both in form and cause, that the descriptive name *cascading glacier* has been proposed for it.

Development of the Ablation Moraine

Glacial erosion, which has produced extraordinary topographic change in the Alaskan mountains, has, among other results, given rise to very steep valley walls. Such steep slopes, produced by ice erosion during the higher stage of the glaciers, are now, on exposure to the air, in a state of instability under the attacks of the agents of subaerial denudation. Therefore, they weather rapidly, and from them rock falls and avalanches frequently descend. This

rock, mixed in the snow out of which the glacier is made, and spread out over its surface, is concentrated by ablation in the dissipator until the ice surface often becomes completely covered by a sheet of moraine, to which the name *ablation moraine* has been given. It is naturally upon the lower ends of the glaciers that the ablation moraine is most extensively developed; but in some instances it extends far up the valleys, almost or quite to the snow-line. Then the valley glacier looks so little like an ice stream that it may not be recognized as one by the casual observer; and on some of the Alaskan maps such glaciers have found no place.

Since only a portion of the Alaskan glaciers bear ablation moraine it is evident that special conditions are demanded for its development. It is best developed on those ice tongues with steep walls and steep heads, whose width is not too great for avalanches to spread out well toward the middle, and whose valley walls are of a friable rock. In proportion as these conditions vary, the extent of the moraine sheet also varies. Normal weathering and the spread of the falling rock through the snow fields and over the ice tongues are undoubtedly sufficient to account for the formation of a sheet of ablation moraine; but the excessive development of such moraine in some portions of the Alaskan region may perhaps be due in part to the aid which earthquake shaking gives in the downthrow of avalanches from the glacier valley walls. When a glacier bearing a sheet of ablation moraine has melted away, it leaves not only a deposit of till with scratched stones, but overlying this a sheet of coarse, angular fragments and weathered materials. Such deposits are to be expected in mountain regions of former glaciation.

Influences Modifying Rate of Recession of Glaciers

The ablation moraine is one of the factors influencing the position and rate of recession of glacier fronts; another factor is the position of the front, whether on the land or in the sea; for in the latter case recession is far more rapid and active than in glaciers ending on the land. For example, in the St. Elias region, while the Guyot, Seward, Marvin, Lucia, Yakutat and other glaciers that end on the land have spread out from one to twenty miles beyond the mountain front, the great, rapidly-moving tidal Hubbard Glacier, near by, ends at the head of Disenchantment Bay, ten miles or more back among the mountains. Both tidal and non-tidal glaciers are exposed to surface wastage by melting and evaporation; but the tidal glaciers are further exposed to the effective attack of the salt water which quickly removes the ice fragments that fall into it. Therefore, other things being equal, the tidal glacier will naturally terminate farther back among the mountains than non-tidal glaciers of similar character.

Glaciers advancing into rivers are also actively attacked, as is illustrated by the Childs and Miles glaciers in the Copper River Valley, and by glaciers in the Alsek Valley. To a lesser degree the same tendency to more rapid retreat is present in glaciers that terminate in lakes, as the Yakutat Glacier does.

Among ice tongues ending on the land there is great difference in the rate of wastage according to exposure and elevation; but even more important is the protective influence of the cover of ablation moraine. This finds best illustration in those glaciers which spread out fan-shaped at the mountain base, attaining a state of stagnation or semi-stagnation along their margins. Here, near sea level, in a rainy,

temperate climate, wastage by ablation would normally be active, and if the ice supply failed the glaciers would rapidly recede. But the sheet of ablation moraine that develops serves as a blanket against both melting and evaporation, and the rate of wastage so decreases with increase in thickness of the morainic cover that there finally comes a condition of almost complete protection. When the moraine cover is no longer subject to frequent undermining and slumping, vegetation finds a foothold, and ultimately even a mature forest may spread over the moraine that blankets the ice. Glacier recession under such conditions almost ceases and an ice terminus may remain for scores of years without notable change, even though ice supply is completely cut off.

In view of the fact that a protected ice terminus may remain so long in one position, it follows that the piedmont condition is not necessarily proof either of recent expansion or of a continuance of ice supply after expansion. Indeed, there is reason to believe that the piedmont glaciers, and the piedmont bulbs of individual glaciers in Alaska have been formed by expansion at entirely different periods. In some the supply is still being maintained and the ice terminus is kept in place by the essential balance between supply and wastage. This seems clearly to be the case in the greater part of the Malaspina Glacier; but elsewhere there is evidence that the expansion occurred during an earlier period of advance, and that the ice supply has long since been withheld. This is true of the piedmont bulbs of Galiano and Lucia glaciers, to the ends of which the effects of even a recent notable advance did not extend. In still other cases, the ends of the bulbs have become almost or even completely separated from the main glacier by wastage of clear ice

areas back of the terminus. The piedmont bulb develops during a period of advance; it may linger, in more or less mutilated condition, through a period of stagnation, receiving redevelopment when next an advance of sufficient volume occurs. In other words, it does not necessarily represent an existing state of activity and supply; for, because of the protection of a blanket of ablation moraine, it may long retain its position even in the face of warmth, abundant rainfall and failure of ice supply.

Marginal and Terminal Deposits

Since on the seaward side of the coastal mountains, the ends of so many large glaciers lie in a temperate, rainy climate, the phenomena of terminal and marginal deposit are illustrated with great clearness, throwing much light on the origin of similar phenomena in the deposits of former continental glaciers. Particularly is this true of the piedmont areas, not only because of the wide extent of their margins, but also because they are existing examples of a type of glacier that was formerly common in the mountain regions of both Europe and America. It can not be made a part of this address to consider this subject in detail, interesting and important thought it is.¹³ Suffice it to say that in Alaska one may see in process of development both lateral and terminal moraines in great variety of form and composition, from stratified gravel or sand, or clay, to true till; eskers and kames; outwash gravel plains and kettles of various forms and sizes; lacustrine deposits of many kinds and marginal lakes of various origins; marginal channels due to erosion

¹³ See Tarr, R. S., "Some Phenomena of the Glacier Margins in the Yakutat Bay Region, Alaska," *Zeitschr. für Gletscherkunde*, Vol. 3, 1908, pp. 81-110; also, "The Yakutat Bay Region, Alaska," U. S. Geol. Survey, Professional Paper 64, 1909.

and the work of marginal streams in deposit; indeed almost the whole series of phenomena which were present along the receding margins of the Pleistocene glaciers. There are phenomena of recession, of advance, and of alternate recession and advance in the course of which soil beds and plant remains were incorporated between distinct sheets of glacial deposits.

Of all the deposits at present being made in association with Alaskan glaciers, those made by the glacial streams are by far the most prominent. During the summer, torrents of water issue from the margins of the glaciers, and, where the ice is stagnant or thin enough for the existence of subglacial tunnels, from the central portions also. These torrents, doubtless esker-building beneath the glacier, spread out over alluvial fans, or broad outwash gravel plains, or long, narrow valley trains, which they are upbuilding by the extensive deposition that is made necessary by the overburdened condition of the streams on their escape from the ice tunnels. Over such a deposit the streams spread in a multitude of anastomosing branches, ever shifting in position as they aggrade their beds in the effort to establish a grade sufficient for the transportation of the sediment load. Within a few miles of the glacier front the slope of the aggrading streams may average 50 or 60 feet to the mile, and close by the glacier even much more than this.

So great is the velocity of the glacial torrents that good-sized stones are dragged along, and one can hear them striking together as they roll on down stream. First the boulders are dropped, then the gravel, then the sand, and with the change in material deposited is an associated change in grade; but throughout their course the grade of the glacial streams is commonly very steep, for they are normally so charge

with sediment, and much of the sediment is so coarse, that it quickly settles in a slow current. Schrader says that in its upper course the Klutena River has a grade of 60 feet a mile, then for 28 miles an average grade of 22 feet a mile and a velocity of 14 miles an hour. The Copper River, into which it empties, flows with a velocity of 8 miles an hour.

The Sediment Supply of the Glacial Streams

In volume, slope and sediment load the Alaskan glacier streams are noteworthy. During a period of a few months each year the drainage of a wide area, locked up in the form of snow and ice, is turned into torrents of running water which issue as full-fledged streams, and even as veritable rivers from near the glacier ends. A glacier that is just at the balance between supply and melting furnishes to the streams only that water which is brought down to or near to the ice front; but in a glacier that is receding, there is added to this supply all that which is melted from the ice that is no longer moving forward. Therefore, where, as is so often the case in Alaska, the glaciers are stagnant or receding, the supply of water exceeds the normal.

The impressive volume of sediment, fine and coarse, which the glacial streams are transporting leads the inquiring mind to raise the question as to its origin. Streams having their source in the rainfall are not often so sediment-laden as the glacial streams normally are; indeed, even the exceptional land-supplied streams are rarely as heavily burdened, even for a few days, as the glacial torrents normally are for several months. Particularly is the question of the origin of the finer grained sediment of interest. It is abnormal in quantity as compared with mountain streams in gen-

eral, and yet it comes from a drainage area largely protected by snow and ice against those atmospheric agencies which transform hard rock to fine clay. Can there be any doubt but that the glacier which protects the rock against the atmospheric agencies must attack it with equal or even greater vigor, in order to obtain this vast burden of sediment that the streams bear away?¹⁴

The Recession of Glaciers in Alaska

Throughout the world the general state of the glaciers is one of recession, with local exceptions; and it is as true of Alaska as of other regions. In the two regions where we have the longest record and the most detailed studies—Glacier Bay and Yakutat Bay—there have been great recessions during the period of observation, the continuation of a still greater earlier recession during the last century or more. For instance, in Yakutat Bay the tidal Nunatak Glacier receded at the rate of over 1,000 feet a year between 1899 and 1906, with a total recession of over a mile; and the nearby Hidden Glacier, ending on the land, receded at about a quarter of this rate. Prior to this observed recession, both Hidden and Nunatak glaciers had been so far advanced that they united and their combined front reached about 20 miles farther out than the present end of Nunatak Glacier, and 10 miles beyond the present terminus of Hidden Glacier. From this advanced position there has been rapid and long-continued recession which was in progress up to 1906 in Hidden Glacier, and up to 1909 in Nunatak Glacier. If the observed rate of recent recession of Nunatak Glacier has been steadily maintained throughout the period, it is to be reckoned as of about a century duration.

¹⁴ See von Engeln, O. D., *Zeitschrift für Gletscherkunde*, Band VI., 1911, pp. 138-144.

In Glacier Bay the phenomena have been closely like those of Yakutat Bay. A long-continued recession had been in progress when the Muir Glacier was studied by Wright in 1886, and by Reid in 1891 and 1892, when Muir Glacier front was about 20 miles further inland than it had been 100 or 150 years before; and Grand Pacific Glacier front was about twice that distance back of the former terminus. Where ice had formerly filled the mountain-walled valley to a depth of 3,000 feet, the flood waters extended in 1892. This recession has continued since then, being especially noteworthy since 1899; and now (1911) both the Grand Pacific and the Muir Glacier fronts are 9 or 10 miles farther back than in 1892, the average recession being at a rate of not far from 2,500 feet a year for the 19 years; but it is to be noted that the rate has not been regular, and that the greater part of the recession has occurred since 1899. The retreat has continued up to 1911 in all the glaciers of Glacier Bay with the single exception of Rendu Glacier (and a small cascading glacier near it), which has recently advanced about a mile and a half. Glacier Bay has been enlarged no less than 50 square miles by ice recession in a period of 19 years. Assuming an average thickness of 750 to 1,000 feet, the total loss of ice in this period is not less than 6 or 8 cubic miles. But to this must be added that which has been lost by ablation from above the present ice surface; and this is also an enormous amount, for all the outer glacier surfaces, even far back from their fronts, are now much lower than they were in 1892.

While these instances are the most striking of which there are records in Alaska, in our own studies Professor Martin and I have observed scores of other cases, widely separated, where there has been notable recent recession and where it is still in prog-

ress; and many instances have been made known to us by the observations of other workers. Therefore, the commonly accepted conclusion that recession is the general rule among the Alaskan glaciers is fully warranted; yet the rule is by no means invariable. For example, Columbia Glacier began advancing in 1908, and Professor Martin found it still advancing in 1910, while in the same year he observed commencement of advance of several glaciers of different sizes in Prince William Sound and Copper River valley. We know also of recent advance of other Alaskan glaciers, the total known to us to have advanced since 1899 being 43, nine of which are in Yakutat Bay; but some of these 43 advances are exceedingly slight; and 43 glaciers form but a minute proportion of the whole number of Alaskan glaciers. These facts demonstrate that it can not be assumed either that the recession is universal, or that it is not liable to interruption. Too little is known about Alaskan glacier history and about Alaskan climate and its variations to warrant any generalization with regard to the possible future of its glaciers; it is not even certain that the present state of general recession is anything more than an episode.

Advance of Glaciers as a Result of Earthquake Shaking

Of all the recent glacier advances of which we have record in Alaska, by far the most interesting are those of Yakutat Bay. Following the vigorous earthquakes of September, 1899, and, as I have elsewhere endeavored to show,¹⁵ as an indirect result

¹⁵ I have presented this theory in various publications, and in these have given a full statement of the facts and a discussion of their bearing on the theory; so that, in view of the character of this address and its necessary briefness, only a very short and general statement is attempted. See especially Tarr, R. S., "Second Expedition

of them has come a series of forward movements and transformations of a very spectacular character, interrupting a period of general recession and affecting even stagnant glaciers and piedmont bulbs. First there came a spasmodic advance of at least two small glaciers, and probably others that we failed to detect on our first expedition in 1905; then, in the interval between September, 1905, and June, 1906, an advance occurred in four larger glaciers; in 1906 and 1907 the Hidden Glacier advanced; in 1909 the still larger Lucia Glacier; and in 1909-10 the Nunatak Glacier advanced. The progressive appearance of the advance, correlated with the length of the glaciers, has been set forth in the following table prepared by Professor Martin:

Name of Glacier	Date of Advance	Approximate Length of Glacier
Galiano	After 1895 and before 1905	2 or 3 miles
Unnamed Glacier	1901	3 or 4 miles
Haenke	1905-6	6 or 7 miles
Atrevida	1905-6	8 miles
Variegated	1905-6	10 miles
Marvine	1905-6	10 miles (exclusive of portion in Malaspina piedmont area)
Hidden	1906 or 1907	16 or 17 miles
Lucia	1909	17 or 18 miles
Nunatak	1910	20 miles

The advance involved a profound breaking of the glacier surface even where pre-to Yakutat Bay, Alaska," *Bull. Geog. Soc. Philadelphia*, Vol. 5, 1907, pp. 1-14; "Recent Advance of Glaciers in the Yakutat Bay Region, Alaska," *Bull. Geol. Soc. America*, Vol. 18, 1907, pp. 257-286; "The Yakutat Bay Region, Alaska," Professional Paper No. 64, U. S. Geol. Survey, 1909; "The Theory of Advance of Glaciers in Response to Earthquake Shaking," *Zeitschrift für Gletscherkunde*, Vol. 5, 1910, pp. 1-35; also Tarr, R. S., and Martin, Lawrence, "Recent Changes of Level in the Yakutat Bay Region, Alaska," *Bull. Geol. Soc. America*, Vol. 17, 1906, pp. 29-64; "The Yakutat Bay Earthquakes of September, 1899," Professional Paper No. 69, U. S. Geol. Survey, 1912 (in press).

viously smooth and uncrevassed; the lower portion of the glacier was greatly thickened; where unconfined between mountain walls there was a notable spreading at the margins; and the free ends of the glaciers were bodily moved forward. In all cases the transformation was rapid and even spasmodic, requiring a period of but a few months for the complete cycle; and in all cases the advance was quickly followed by relapse into the previous state. In other words, a wave spread down through the glaciers with accompanying thickening, spreading, advance and breaking of the rigid upper ice; but after passage the glacier was left in essentially the same state of activity as before, even though that state had been complete stagnation in parts of the affected area.

In some cases the wave spent its effects in breaking, thickening and spreading a piedmont bulb, with little actual advance; in others, the effects of the thrust being confined by bordering mountain walls, and thereby concentrated on the frontal end, there was notable advance of the terminus. Such an advance is best illustrated in the Hidden Glacier, whose front was pushed forward about two miles; and where the ice front stood in 1906 the glacier was 1,100 feet thick after the advance. During a brief, spasmodic advance, at least a third of a cubic mile of ice moved beyond the 1906 front; and great volumes of ice were also added to the glacier back of the old front, for in 1909 the glacier surface rose to a far greater height than in 1905 and 1906.

The theory put forward to account for this series of glacier advances is that the vigorous earthquakes of September, 1899 shook down such great avalanches of snow, ice and rock in the glacier reservoirs as to necessitate a wave of advance that swept down through the glaciers, reaching the

terminus of the smaller ice tongues very quickly, and the larger ones at later dates, while up to the period of our last observations, in 1910, the very largest glaciers had not yet responded. Since the cause was a sudden and concentrated addition of large supplies to the glacier reservoirs, the resulting wave was naturally rapid in its passage, and it quickly subsided, while its effects in passing were both spasmodic and extreme.

A study of four seasons discovers only evidence favoring this theory, and since it is an efficient cause, known to have been actually present, while no facts are known to oppose it and a great number favor it, I feel convinced that the earthquake avalanche theory merits the wide acceptance that it has received. It adds a new, and, in favorable regions, probably a very important cause for fluctuations in glacier margins. How widely it may be extended in explanation of other glacier advances remains to be established by future studies; it is not to be expected that it will replace the theory of climatic cause for glacier fluctuations; but it may well be expected to supplement it and perhaps in part replace it in regions of frequent earthquakes.

Local Nature of Recent Great Advances

It is too early to attempt to explain all the known variations in Alaskan glaciers, for as yet the body of fact is limited both as to time and as to area. Yet there are some significant features that are well worthy of consideration. Attention has already been directed to the fact that there has been a very great recent recession of the ice fronts in Glacier Bay and a similar recession in the Yakutat Bay region 150 miles to the northwest. This recession, which has been in progress for the past century or more, is really but part of a cycle in which the glaciers are still receding toward

a former minimum. Having at an earlier period been far advanced, and having held this position for a long time, the glaciers in both regions receded to a stand even farther back than the present ice fronts, and remained there long enough to permit the growth of mature forest; then came an advance pushing the ice fronts forward from 20 to 50 miles. This advance is known to have been of brief duration, for the gravels over which the glaciers advanced were not removed by the ice erosion; and it was quickly succeeded by the rapid recession that has been in progress during most of the period of observation.

So great an advance, followed by so great a recession, might be expected to be part of a general cycle affecting all or a large part of the Alaskan field. Yet such is not the case, for in Prince William Sound, 250 to 300 miles to the west of Yakutat Bay, the recent glacier history has been wholly different. In no case have the glaciers recently had a position far beyond their present fronts, while in some cases it is certain that they are to-day as far out as they have been in a century or two. This is especially clearly seen to be the case in Columbia Glacier, which in 1909 and 1910 was advancing into and destroying a mature forest. Forest also grows on the mountain slopes above the glacier for many miles back from its front, suggesting that this glacier is now in a state of unusual advance analogous to that experienced a century or more ago by glaciers to the southeast. Since there is no reason to suspect that a *general* cause which was operating to bring about glacier advance in the Alaskan coastal region could suffer retardation of a full century in the Prince William Sound region, we are forced to the alternate view that even such great advances and recessions as those proved for the Yakutat and Glacier Bay regions are

localized phenomena. Whether due to uplift or depression, to vigorous and repeated earthquake shakings, or to local climatic variations remains yet to be determined.

Cause of the Recent Retreat of Muir Glacier

It has been a generally favorite theory that the remarkable recession of Muir Glacier since 1899 is an indirect result of the great earthquakes of September, 1899. Latterly it has been proposed that the recession is due not to this cause, but to the enlargement of ice area exposed to the sea water and consequently to wastage by iceberg discharge. Neither of these theories, nor the two combined, are either competent or needed to explain the phenomena of recession, though doubtless each has been a factor in it. Granting the maximum disturbance by earthquake shaking, and granting even that the glacier could be broken from surface to bottom, which is highly improbable in view of the nature of ice under pressure, the cracks would certainly heal and the ice become welded in its lower portions soon after the breaking. There would be no basis for the continuation of the effect of the earthquakes for a number of years after the shocks themselves had died out; yet recession has continued for twelve years after the earthquakes. Moreover, recession began many years before the earthquakes, though the rate has been much increased since 1899. As to the theory that the recession is due to the enlarged area of ice exposed to salt water, that is surely an efficient aid in recession; but it does not account for the continuation of notable recession of other glaciers in the region which now have less, rather than greater, area exposed to the salt water. Nor does it account for the excessive wastage along land margins and on ice surfaces back from the fronts.

In view of the fact that the glaciers of Yakutat and Glacier bays have been in a state of rapid recession for a century or more, all that is necessary in explanation of the recession since 1899 is to consider it an accelerated part of this grand retreat which must be due to a deficiency of snow supply following an excess in supply, or an emptying of the glacier reservoirs succeeding a filling of them. Of course, the rate of recession may readily have been temporarily modified by crevassing due to earthquake shaking, or locally modified by variation in exposure to wastage, or checked or increased by variations in precipitation or temperature. These, or any other temporary or local causes, are but minor episodes in the general withdrawal of glaciers which a century or two ago had, for some reason as yet unknown, been made to advance farther than they could maintain their fronts.

Some of the Factors Involved in the Phenomena of Advance and Retreat

Under the simplest of circumstances the advance or retreat of a series of glaciers is a complex phenomenon in which so many factors are involved that a full analysis of them can not be undertaken here. Yet some of the factors stand out with such distinctness that I may take time to briefly point them out. The nature of the glacier terminus is of fundamental importance. If the end of an ice tongue is in water it makes a great difference in the rate both of advance and recession whether the water is salt or fresh, whether it is deep or shallow, whether it is in active movement or is quiet, whether there is or is not a free escape for the icebergs, and whether the relative area of ice cliff is small or great. All these factors are effective in addition to the rate of supply of ice to be discharged. If, on the other hand, the ter-

minus is on the land, there are influences of exposure, of elevation, and of amount of moraine cover, as well as the amount of ice supplied.

Illustration from Yakutat Bay

It is clear that there must be a very great difference, especially in recession, according to whether the ice front is on the land or in the sea, for in the latter position wastage is far more rapid than in the former. This finds clear illustration in the Yakutat Bay region, for during the recent great expansion of the glaciers, a century or more ago, not only were the tidal Nunatak, Turner and Hubbard glaciers caused to advance, but the glaciers ending on the land also pushed forward, presumably at about the same time. Along the margin of Malaspina Glacier, for instance, the same phenomena of overridden gravels and buried forests are discovered as in the area over which Nunatak-Hidden Glacier advanced. But while the tidal glaciers have receded 10 to 20 miles, the recession of Malaspina Glacier has been, at the most, but a fraction of a mile; and in some parts of its moraine-covered margin, on which forest grows, it has remained practically stationary for at least half a century. This extreme difference may possibly be in part due to a more constant maintenance of the ice supply in the Malaspina Glacier, though of this there is no proof; it certainly is *partly* due to the difference in rate of recession of glaciers terminating on the land and in the sea.

Modification of Local Climate as a Result of Advance and Retreat

In interpreting both the cause and the rate of advance or recession of glaciers it is evident that the mere fact of advance encourages advance, while recession encourages continuation of recession. When

a glacier advances, the area of ice surface is increased, and its level rises, while with retreat the glacier surface is lowered and the area of ice is decreased; and if the terminus is in the sea there is a variation in the amount of floating ice with advance or recession. These changes produce a very pronounced effect on local climate, influencing both snowfall and ablation. Though the extent of the influence is naturally variable, it is roughly proportionate to the amount of the advance or retreat and to the area and height to which the variation extends. Other things being equal, the influence of an advance in encouraging advance is greater and more prolonged when the ice ends on the land than when its terminus is in the sea; for on the land the ice spreads farther and remains in position longer. Thus the climatic influence of the last advance of Malaspina Glacier is still dominant, while that of the neighboring Hubbard Glacier has been very greatly reduced by its notable recession.

In illustration of these principles it may be stated that photographs of Hidden Glacier, which in the interval between 1905 and 1909 had advanced two miles and had become greatly thickened, show a very notable difference in the amount of snow on and above the ice. This is undoubtedly due to the double cause of greater snowfall and decreased melting, brought about by a modification of the local climate as a result of the advance. At Muir Glacier, which in the interval between 1892 and 1911 has suffered such excessive recession and lowering of its surface, the climatic difference is also distinctly noticeable in photographs, but with results of exactly the opposite kind. Here there is a smaller area of ice, the surface of that which remains is much lower than formerly, a larger proportion of the sur-

face is covered with moraine or discolored by débris, and the snow-covered area on the mountain slopes is greatly diminished. Without doubt the depth of annual snowfall is markedly decreased, while the amount of ablation is notably increased in 1911, as compared with 1892. Thus when a deficiency of snowfall, or other cause gives rise to a recession, the rate of ablation may come to be considerably in excess of the amount by which the ice supply is deficient, and the rate of retreat therefore may become much more rapid than would be expected from the mere difference in ice supply.

Recession Following Advance

The problem of advance and recession is still further complicated by the apparent manner in which glacier advances take place. As shown by Finsterwalder and others,¹⁰ the Vernagt Glacier of the Tyrol responds to climatic variations by the passage through the glacier of a wave which causes the terminus to move forward, the forward movement being concentrated in a brief period of time. Other glaciers, in the Himalayas, in Patagonia and in Spitz-

¹⁰ Finsterwalder, S., "Der Vernagtferner," *Wissenschaftliche Ergänzungshefte zur Zeitschrift des D. u. O. Alpenvereins*, 1. Band, 1. Heft, Graz, 1897; Anhang, Blumcke, A., und Hess, H., "Die Nachmessungen am Vernagtferner"; Blumcke, A., und Hess, H., "Beobachtungen an den Gletschern des Rofentales," *Mitt. des D. u. O. A.-V.*, Jahrgang 1900, Nr. 4; "Einiges über den Vernagtferner," *ibid.*, Jahrgang 1902, No. 18; "Tiefbohrungen auf dem Hintereisferner," 1902, *ibid.*, Jahrgang 1902, Nr. 21; "Tiefbohrungen am Hintereisferner im Sommer 1908," *Zeitschrift für Gletscherkunde*, Band III., 1909, pp. 232-236; "Tiefbohrungen am Hintereisgletscher," 1909, *ibid.*, Band IV., 1909, pp. 66-70; Hess, H., "Zur Mechanik der Gletschervorstöße," *Petermanns Geogr. Mitt.*, 1902, Heft V.; Hess, H., "Probleme der Gletscherkunde," *Zeitschrift für Gletscherkunde*, Band I., 1906, pp. 241-254.

bergen, whose ends have been rapidly and notably pushed forward are apparently illustrations of the same principle; and because of the peculiar nature of the cause for the wave, the Yakutat Bay glaciers furnish illustrations of an even more spasmodic movement, and a more rapid subsidence of the wave of advance. There are many instances of minor, or minute, advances of glacier fronts; and we also know of a number of cases of noteworthy advances in Alaska and elsewhere. The more notable advances seem to be illustrations of the same principle, that a wave of advance, concentrated on the terminus of the glacier, pushes it far forward; then follows a relative deficiency of supply and consequent retreat. In the recently advanced glaciers of the Yakutat Bay region the subsequent deficiency has been so great that stagnation has immediately followed advance.

We have not yet large enough body of fact to warrant the statement of a law, but such knowledge as we possess indicates that there is reason to expect relatively rapid recession following an advance, because a deficiency of supply follows as a necessary result of the utilization of a part of the ice supply in the progress of the wave of advance. In other words, the reservoir is temporarily depleted by the drain upon it during the advance.

FORMER GLACIATION

The major part of this address has been devoted to the existing glaciers and their recent history, for this has been the field of my most extensive study. But little time remains for a consideration of the former glaciation, and what is said must of necessity be brief, and must deal with only the most general and fundamental points.

Extent of Former Glaciers

It is now a well-known fact that in recent geologic time there has been a very notable expansion of Alaskan glaciers both along the coast and in the interior. The fiords of southeastern Alaska were filled with ice to their seaward entrances, and the same was true as far west as the Alaska Peninsula. Thus there was a vastly greater ice-covered area on the seaward side of the coastal mountains than now exists there. In the interior there was also notable expansion on the inner side of the coastal mountains, on both sides of the Wrangell and Alaska ranges, and in the Endicott Mountains. Elsewhere in the mountains of the interior, even where now there are no living glaciers, there were valley tongues, and perhaps even expanded piedmont bulbs. All this glaciation was, however, purely of the mountain type, and far the greater part of Alaska was untouched by it.

Along the coast there were extensive piedmont glaciers, and there were vast piedmont ice sheets filling the fiords to a depth of several thousand feet, overflowing the low islands and peninsulas now separating them, and discharging icebergs into the ocean. Piedmont glaciers also developed along the inner face of the coastal mountains and on both sides of the Wrangell Mountains, and the Alaska Range.

By far the greatest area of ice in the interior was that which, in its maximum stage, nearly or quite filled the great basin that lies between the coastal mountains, the Wrangell Mountains and the Alaska Range, forming a great *intermont* glacier by the junction of a series of piedmont glaciers. The exact extent and the characteristics of this glacier are not yet determined; and it is not certain that it filled the entire Copper River Basin, though it

probably did, and even extended into the Susitna Valley.

Deposits of Former Glaciers

The deposits of this former glaciation are not usually extensive among the mountains, whence they have easily been removed by subsequent denudation; nor are they very notable in most places along the coast, for there the greater portion of the deposits doubtless lies beneath the sea. Only in a few places, as in the foreland that skirts the seaward base of the Fairweather Range, is there an extensive area of deposit above sea level; elsewhere the general scarcity of glacial deposit is usually striking.

In the interior, on the other hand, and notably in the Copper River Basin, there is a remarkable development of glacial and glacio-fluvial deposit formed during the period of glaciation and during its stages of advance and of recession, of which the present must be considered a part. Here one finds the greater number of glacial features common to an area of continental glaciation—lake and glacial stream deposits, loess, till, eskers, kames, moraines, and marginal channels are found in perfect development over a wide area. One familiar with glacial deposits in Europe or America finds himself quite at home in the Copper River Basin.

The Period of Expansion

There has not been enough study of the glacial deposits to render it possible to state whether the history of the glaciation in Alaska presents the same complexity as that observed in Europe and eastern America; nor can it even be assumed that the Alaskan glaciation was contemporaneous with the glaciation of these lands. Yet, although very extensive glaciers still exist in Alaska, and although these are certainly

the descendants of the former expanded glaciers, it is entirely possible that the time since the maximum expansion is as great as that in other northern lands, such as Norway and Scotland. I can see no noticeable difference either in the extent of post-glacial denudation, or in the weathering of glacial deposits in Alaska and the Alps, or Norway, or Scotland. The greatest expansion of Alaskan glaciers certainly occurred many centuries ago, and may well have been as long ago as the time when the glaciers of the Alps shrank back into the mountain valleys. The vast work performed by glacial erosion in the Alaskan fiords clearly proves that the period of expansion of glaciers was of long duration.

Difference in Extent of Recession

There is one very puzzling condition that renders the solution of the problem of the time of maximum expansion difficult to solve. In southeastern Alaska and in Prince William Sound the tidal glacier fronts now lie from 75 to 100 miles farther back than they were in the period of greatest expansion, and vast areas of land and water have been uncovered by the recession of the glaciers. So also there has been a very large area uncovered by glacier recession in interior Alaska. But in the coastal area between Cross Sound and Prince William Sound, the glaciers of to-day appear to be only slightly less extensive than they were at the maximum. According to G. C. Martin,¹⁷ the present surface of Martin River Glacier is only 600 or 700 feet lower than during the maximum glaciation, while Bering Glacier is only about 200 feet lower; and the horizontal extension of the glaciers at the period of maximum expansion was only very slightly beyond the

¹⁷ Martin, G. C., "Geology and Mineral Resources of the Controller Bay Region, Alaska," Bull. No. 375, U. S. Geol. Survey, 1908, pp. 50-52.

present borders. Malaspina Glacier has shrunk more than the Bering, but even this is far nearer the maximum than the glaciers of Prince William Sound toward the west, or those of the Inside Passage to the southeast, or those of the interior to the north. In the same region with Malaspina Glacier, the expansion of the Nunatak-Hidden Glacier, of a century or more ago, extended to within 10 or 15 miles of the earlier maximum.

From these facts it is evident that locally, near the center of the coastal area of Alaskan glaciation, the present day glaciers are only a little short of their former maximum. This may be due to recent extensive uplift of the mountains in which these glaciers have their source, or to other local causes; or the entire history of Alaskan glaciation may be related to changes in elevation, and wholly unrelated to those causes that gave rise to the development of continental glaciation in Europe and eastern North America. We are not now in possession of a sufficient body of fact to warrant further discussion of this problem.

CONCLUSION

This brief analysis makes it clear that up to the present time only a beginning has been made in the research in the field of Alaskan glaciers and glaciation. Enough has been done, however, to show the existence of interesting and important problems, to permit a few of them to be set forth in concrete form, and to discover facts that have a bearing upon some of them. But there is so much yet to be learned, so many more facts are needed, there is so wide a field that is wholly unknown, and the period of observation is so limited that any one who undertakes to consider the general problems of this broad and complicated field can not but feel appalled at the limitations surrounding his

attempt. At best, with all the help that he can obtain from the work of others, he can only hope to make a step toward the understanding of the conditions and problems of this great field. I do not delude myself with the belief that in this address I have done more than this.

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PROFESSOR GEORGE DAVIDSON

IN San Francisco on December 1, 1911, Professor George Davidson quietly ended a long life of active and valuable service to his country. Men of science the world over are expressing their sorrow at his passing, but everywhere there swells also the strong note of pride and satisfaction in the magnificent example which he has given of what may be accomplished by the devotion of a clean, strong life to a chosen field of work. Beginning his independent scientific observations in 1843 as magnetic observer for Girard College, he devoted sixty-eight years of virile manhood to geodesy, geography and astronomy. For fifty years of this long period he was uninterruptedly in the service of the United States Coast and Geodetic Survey. Three years after his retirement in 1895 from the survey he was elected to the professorship of geography in the University of California, with which institution he was connected to the time of his death. This change in his nominal employment made, however, no serious break in the continuity of his life of study and research. The exceptional character of his mental and physical virility is strikingly shown by his election to the faculty of the University of California at the age of 73—eight years beyond the limit usually fixed for the retirement of college professors.

Few men can read the brief sketch which follows without some feeling of surprise that the life of a contemporary should reach so far back into the history of another generation. Born in Nottingham, England, on May 9, 1825, in early boyhood he was brought to the United States by his parents, who settled in

Pennsylvania in 1832. He was educated in the Central High School of Philadelphia, an institution which by the school organization of that time was entitled to confer college degrees and which had an able corps of instructors. Among the faculty was Professor A. Dalles Bache. Professor Bache's high regard for the young student led to his appointment, in 1843, as magnetic observer at Girard College. Meanwhile Professor Bache was made superintendent of the United States Coast Survey and in 1845 young Davidson, then only 20 years of age, was appointed as clerk and computer to serve in the office of the superintendent. This appointment determined his life work, for he remained in the service just one half century. In 1850 at his request he was assigned to duty on the Pacific coast, where for the next ten years he surveyed harbors, selected sites for lighthouses and determined geographical positions along the coast from San Diego to Puget Sound. This pioneer work was of the greatest importance to navigators, his observations during this period being the foundation for his "Coast Pilot or Directory of the Pacific Coast," the first edition of which appeared in 1857.

At the outbreak of the civil war he was assigned to the Atlantic coast, where he was first employed as engineer on the defenses of the Delaware River. In 1862 he was in charge of the Coast Survey steamer *Vixen*, detailed for special naval service along the Florida coast. The next year, when Lee invaded Pennsylvania, he was made assistant engineer of Philadelphia.

The frequent connection of Professor Davidson with important events in the history of the United States is well illustrated by his assignments for the year 1867. In January he was detailed on duty as engineer of a party sent to the Isthmus of Panama to search for the best location for a ship canal. A few months later he was in Alaska making a preliminary geographical survey of that territory, the purchase of which was then being negotiated by the United States. His report on Alaska met the warm approval of Secretary of State Seward, and greatly influenced the

consummation of the purchase. One rare accomplishment of Professor Davidson was his ability to do reconnaissance quickly and effectively—an especially valuable quality for a man doing scientific work in a new country.

In 1868 he was promoted to charge of the United States Coast Survey on the Pacific coast, a position which he retained until June, 1895. This period was in many ways the richest and most productive of his life. He not only directed the work of the various field parties and personally made some notable geodetic and astronomical surveys, but he also served on government commissions in various parts of the world.

In 1872 and again in 1884 he was appointed by the President upon the Assay Commission to test the weight and fineness of the coins of the Philadelphia Mint, and in both instances made all the weighings and introduced new methods. Twice he was appointed by the Secretary of the Treasury to examine the assay, coin and bullion weights and the balances and beams of the United States Mint at San Francisco.

In 1873 he was appointed by President Grant one of the three commissioners of irrigation of California, and in the following year was sent to China, India, Egypt and Europe to examine and report upon irrigation and reclamation works. In 1888 President Cleveland appointed him a member of the Mississippi River Commission. In 1889 he was appointed by President Harrison a delegate to the International Geodetic Convention at Paris, and was commissioned to bring to Washington the international prototypes of the standard meter and kilogram. While abroad on this mission he visited the observatories of Paris, Berlin and Greenwich, and was received with high honors.

Many scientific societies have elected him to membership: Bureau des Longitudes de France; honorary member Berlin Geographische Gesellschaft; Royal Geographical Society; Scottish Royal Geographical Society; Swedish Society of Anthropology and Geography; Paris Academy, Institut de France; the Philadelphia Academy of Science in 1853;

of the National Academy of Science in 1874, and many others. He was president of the Geographical Society of the Pacific since its organization in 1881. He received the degree of Ph.D. from Santa Clara College in 1876; Sc.D. from the University of Pennsylvania in 1889, and LL.D. from the University of California in 1910. Norway conferred upon him the Cross of the Royal Order of St. Olaf in 1907, and the American Geographical Society awarded him the Charles P. Daly medal in 1908.

In California he was frequently called upon to give advice in the great engineering problems of San Francisco and of the state. He served as regent of the University of California from 1877 to 1884, and was a member of many state commissions. It was largely through his suggestion and influence that James Lick finally decided to build and endow the great Lick Observatory.

Professor Davidson is also favorably known for his accurate astronomical work. He was in charge of the solar eclipse expedition to Alaska in 1869 and took his 6½-inch equatorial to the top of Santa Lucia (over 6,000 feet) to observe the total eclipse of 1880. He had charge of the American Transit of Venus Expedition to Japan in 1874 and of the party to New Mexico for the transit of 1882. The Davidson Observatory in Lafayette Park, San Francisco, where he made many valuable observations, was established and maintained by him for twenty years. His remarkably fine drawing of Saturn is a monument to his acute eyesight and to his delicate skill in delineation.

The name of Davidson is inseparably connected with the foundations of accurate map work in the state of California. His long study of the coast line is embodied in the many survey charts and in the final edition of his "Coast Pilot," which was published in 1889. The north-flowing current now known as the Davidson inshore eddy, was discovered by him and studied particularly in regard to its effect upon harbor improvements.

The only base lines in California, the lines upon which all the distances involved in the extensive triangulation of the state depend,

were located and accurately determined by Professor Davidson, the Yolo base line being twice measured by him in 1881 and the Los Angeles base line three times in 1888-89. A recent report of the Coast and Geodetic Survey puts the probable error in this work as about the one-ten-thousandth part of one per cent. The location of the northeastern boundary line of California, the 120th meridian, was finally determined by him in 1873, and the diagonal boundary of 405 miles from Lake Tahoe to the Colorado River was located and marked under his supervision in 1893. This line is interesting because at each end it terminates in a body of water.

This fragmentary account affords but an imperfect idea of the breadth and scope of the work of Professor Davidson. The fact that in all the many problems of his main work his scientific accuracy stands practically unchallenged is due to his wonderful capacity for untiring effort, to his acute eyesight as an observer, and to his fixed habit of patiently and conscientiously verifying every observation.

In the seventies, when reoccupation of some of his old stations by later parties threw some doubt on his observations fixing the exact position of Mt. Tamalpais, he boldly asserted that his work was right, that the mountain might have moved, but that he had correctly determined its location at the time. After the earthquake of 1906 there was made a careful and extensive survey of central California, which, compared with the surveys before and after the earthquake of 1868, confirmed the accuracy of Professor Davidson's original observations and also his explanation of the apparent discrepancies.

Simple and unassuming in appearance, he bore the mark of one accustomed to command, and possessed a strong and dominating personality. The men who served under him learned at once to obey unquestioningly his slightest order, yet his warm-hearted and generous nature caused them to be strongly attached to him. It has been said that his life work extended through sixty-eight years of active manhood, and rightly so, although one in-

firmity partially disabled him in later years. He was made professor emeritus in 1905 and freed from any obligation to do university work, yet he voluntarily continued his classes for two years in spite of failing eyesight. The necessity of submitting to an operation for cataract finally compelled him to give up lecturing. Although the operation was but partially successful, several papers were prepared by him in these later years. Professor Davidson's indomitable will kept him at work when he was able to read only through a narrow slit in blackened cardboard under favorable light and with the help of the strongest glasses.

Under such circumstances he wrote and published in 1908 his paper on "Francis Drake on the Northwest Coast of America" and, in 1910, the paper on "The Origin and Meaning of the Name California." Both these papers necessitated the careful reading of old maps and manuscripts and yet every point was verified and compared in his manuscript and also in final proof with his original source of information.

To the last he stood as erect as a young soldier, and his voice rang with the courage that he never lost. To those who knew him personally his memory will be treasured because of his warm heart and manly character. The record of his life is an inspiration toward untiring conscientious scientific work.

RULIFF S. HOLWAY

MUSEUM EXTENSION WORK IN CHICAGO

THREE years ago the Chicago Academy of Sciences undertook an educational and museum extension policy which was new in that city. The work has been done in cooperation with the public and private schools of the city. Nearly one hundred museum loan collections have been prepared for distribution among the schools. During the year 1911, 279 loans were made to 44 different schools. Each collection thus loaned was used with at least fifty children and, in many cases, with several hundred children before it was returned to the academy. It is estimated that in this way the loan collections have been used dur-

ing the past year with upwards of 20,000 children.

Instructional courses were offered at the academy free of charge to the children who wished to come. These classes were so crowded that a delegate plan was devised which is probably unique in museum work. Each school room of a given grade may select a representative and that representative comes to the academy as a "little reporter." With note-book and pencil in hand, and with ready questions, these "reporters" make every effort to be well prepared to transmit to their classmates the lessons of which they have had the advantage. In this way the instructional work of the academy has been reaching thousands of children in the public schools each week. Fifty-six schools were represented by 553 delegates in the instructional courses at the academy. Through this method of representatives from the different classes, the work of the academy during the past year has been reported to many children.

Instructional courses to teachers were given. Some of these courses were in the laboratory and others in the field. The teachers were organized into groups to carry on special studies in the plant and animal life of the Chicago region. The study of birds and wild flowers were perhaps the most popular courses thus undertaken.

The transition of the academy from a natural history museum, organized chiefly for the benefit of its members, to an active educational institution conducted chiefly for the benefit of the community, has been carried on under the leadership of the president, Professor T. C. Chamberlin, head of the department of geology at the University of Chicago. The educational work was entrusted, three years ago, to Dr. Wallace W. Atwood, who has had immediate charge of the development of this phase of museum extension work and has organized the various courses of instruction and the methods of taking the museum to the people and especially to the children in the schools. Mr. La Verne W. Noyes, president of the board of trustees, has taken an active interest in the development of this

phase of the instructional work of the institution and has made many suggestions which have proved successful. The latest plan in museum extension work is the preparation of special museum loan exhibits. One of these special exhibits has just been prepared and is ready to be placed in the public schools, park houses, social settlements and branch libraries. The exhibit is entitled "Birds Wintering in the Chicago Region." The foreground is a miniature reproduction of the shore of Lake Michigan. Eleven birds are placed in the foreground and, by means of an oil painting, the scene is carried far into the distance. This is a type of habitat group which will be distributed and loaned free of charge. In this way a modern piece of museum work will be taken to many who may not have an opportunity to visit the main building. The ideas of museum extension is being taken up by various other organizations in the city. The Woman's Club has installed civic and health exhibits in the public schools. The social settlements, the School of Civics and Philanthropy, Municipal Art League, Council for Museum and Library Extension, are all at work on plans for special exhibits at educational centers. This is a period of unusual activity in this field and the recent gift of Mr. N. W. Harris of \$250,000 to the Field Museum will make possible still larger development of this movement in Chicago. The influence of this activity within the city is being felt throughout the state and many calls are received from rural districts for museum loan collections. The Illinois Audubon Society has made some provision for meeting this demand throughout the state. It has in constant use four traveling libraries, four bird-picture collections and two lantern-slide collections with accompanying lectures. These are distributed free of charge. The Chicago Child Welfare Exhibit has aroused wide-spread interest in the preparation of special exhibits for educational purposes.

THE AMERICAN MUSEUM OF NATURAL HISTORY

THE forty-third annual meeting of the trustees of the American Museum of Natural

History was held Monday evening, February 5, 1912, at the Union Club, where the trustees were the guests of Mr. Thomas DeWitt Cuyler, of Philadelphia.

The following were elected officers for the ensuing year:

President—Henry Fairfield Osborn.

First Vice-president—Cleveland H. Dodge.

Second Vice-president—J. P. Morgan, Jr.

Treasurer—Charles Lanier.

Secretary—Archer M. Huntington.

The president presented his annual report and announced the gift to the museum of the Catlin collection of Indian paintings, which was presented by Mr. Ogden Mills, and the Bailey collection of meteorites, which was the gift of Mr. J. P. Morgan, Jr.

According to the president's report, the total attendance for the year was 724,141, which is 100,000 greater than the attendance of last year; the number of pupils studying the circulating collection was 1,253,435, an increase of 300,000 over 1910; the membership has been increased by the enrolment of 349 new members.

Plans are being formulated for the celebration of the fiftieth anniversary of the founding of the museum, on April 6, 1919.

A comparison of the expenditures for the year shows that while the city's contribution was \$189,757, the trustees and the friends of the museum contributed \$216,404.

The building plans for the future include the construction of an east entrance hall on Central Park West and an entrance hall opposite 79th Street on Columbus Avenue. The future exhibition halls that are under consideration are the

Geographic Hall, East Wing, First Floor,
African Hall, East Wing, Second Floor,
Oceanographic Hall, Southeast Wing, First Floor,
Whale Court, Southeast Court, First Floor,
Ichthyology Hall, Southeast Wing, Second Floor.

The president emphasizes the necessity of increasing the present endowment fund.

Election to Membership: Mr. Ogden Mills was elected an associate benefactor in recognition of his gift of the Catlin collection of Indian paintings. Mrs. Isaac M. Dyckman was elected a patron in recognition of her con-

tribution for the preparation and publication of a bibliography on fishes. The Duke of Bedford was elected a fellow for his generosity in presenting to the museum two fine examples of the Prjevalsky horse, a species which has hitherto been unrepresented in the collections. Mr. Anthony R. Kuser was elected a fellow in recognition of his offer to present to the museum a collection of pheasants of the world. Lieutenant George T. Emmons was made an honorary fellow in recognition of his services in furnishing information in regard to the Indians of the Northwest Coast and in promoting field work in this region. Mr. George Bird Grinnell was elected an honorary fellow in recognition of his services in the development of the museum's department of anthropology. Sir Ernest Shackleton was elected a life member in recognition of his splendid achievements in the field of exploration, as well as for his generosity in presenting to the museum a collection of minerals from the south polar region. Dr. Leonard C. Sanford was made a life member in recognition of his generosity in placing his superb collection of birds of the world at the disposal of the curators of the museum for study and reference.

CATLIN PAINTINGS

George Catlin was the first great Indian painter and writer. He was born in Wilkesbarre, Pennsylvania, in 1796, was educated as a lawyer, but in 1823 gave up the profession for art, opening a studio in Philadelphia. A few years after he painted the famous portrait of Mrs. Madison and that of Governor De Witt Clinton, now hanging in the City Hall of New York. He early became a miniature painter, a collection of his works being in the hands of a private collector in Minnesota. Once a delegation of Indians passing through Philadelphia on the way to Washington so impressed Catlin that he planned to travel and paint the various wild tribes. Accordingly he set out and spent eight years, during which time he visited forty-eight different tribes, making portraits and sketches of scenes from daily life. Some years afterward he issued

a large illustrated work on the North American Indians which is still one of our most important publications. Mr. Catlin died in New York City in 1872, leaving in the hands of his daughter, Miss Elizabeth W. Catlin, a large collection of paintings and sketches, which has just been acquired by the museum.

This collection, comprising some 350 oil paintings, represents chiefly the tribes between the Mississippi and the Rocky Mountains as observed during the years 1832 to 1840. Many of them are the originals for the plates in the author's well-known books. Their historic value is very great, as they are the earliest authentic sketches representing the costume, ceremonies, habitations, etc., of the wild tribes. At the time Catlin visited these tribes they were practically uninfluenced by civilization. A well-known artist says: "This collection is by far the most interesting and complete in existence and for the Indian artist is invaluable, the subjects represented covering the entire life, costumes, ceremonies, etc., at a time when Indian life was real, that is, before the transition period in Indian history. I have known Indians for forty years and have seen many who were very little influenced by contact with the white man and I can vouch for the truthfulness of these pictures. They are, outside of Bodmer's and Captain Eastman's pictures, the only record we have of the Plains Indians and are valuable as a pictorial record. I want to speak of another view which the scientist does not appreciate. These Catlin pictures are the most decorative Indian pictures that have ever been painted. There is not a picture in the collection that I would not be proud to hang on my wall. They have a grand beauty of line composition, a great harmony of tone that makes them very valuable as works of art. They have the scenic charm of a Japanese print."

Thus, Catlin may be considered the original Indian artist, the predecessor of Curtis, Schoolcraft, McKenna and Hall and a host of lesser lights. For the museum, the collection will be especially valuable, since it gives us not only highly decorative canvasses, but illustrative series which may be installed

among the ethnological collections where the various scenes will show to the visitor Indian life as it once was.

Perhaps the most unique portion of the collection is the South American sketches. Alexander von Humboldt, whom Catlin met in Europe, was so impressed with the work that he urged Catlin to spend some time traveling in South America. Accordingly, in 1852, Mr. Catlin set sail for Venezuela, from whose coast he passed into the interior and over into the valley of the Amazon. For six years he explored South America, visiting all the tribes on the Pacific Slope, wandering through Yucatan, and portions of Old Mexico and later sailing for Buenos Ayres, from whence he ascended the Parana River to the north and again traversed the entire coast line of Patagonia through the Straits of Magellan. As a result of this work we have ninety canvasses representing characteristic scenes among the natives of tropical and other portions of South America.

BAILEY METEORITES

Through the generosity of Mr. J. P. Morgan, Jr., the museum has acquired the collections of meteorites and minerals that were left by the late Mr. S. C. H. Bailey. Mr. Bailey was an indefatigable collector and exchanger in both branches of science, and his series of meteorites was known as one of the largest in private hands in the number of falls and finds represented. About three hundred meteorites were received by the museum, many of which are new to its already large collection. The most important fall represented is that known as Tomhannock, on account of its having been found on Tomhannock Creek, near Troy, Rensselaer County, New York. Only six meteorites, four iron and two stone, have been discovered within the limits of the state, five of which have been cut up and distributed throughout the collections of the world and most of the larger pieces are in European museums. The main mass of Tomhannock, however, remained with Mr. Bailey, and the museum is fortunate in coming into possession of it. It is an aerolite, or stone meteorite, which was first discovered in 1863,

but was not described until 1887, when Mr. Bailey gave it its present name. The entire original mass weighed only about three and one half pounds, was well rounded and covered with the fusion crust so characteristic of meteorites. Only about one tenth of the original mass was cut off and divided among museums. Hence the part that has now come to the American Museum is nearly nine tenths of the original.

SCIENTIFIC NOTES AND NEWS

LORD LISTER died at his home in London on February 11 at the age of eighty-four years.

At the annual meeting of the Royal Meteorological Society on January 17 the president, Dr. H. N. Dickson, presented to Professor Cleveland Abbe, of the U. S. Weather Bureau, Washington, the Symons gold medal for 1912, which had been awarded to him in consideration of his distinguished work in connection with instrumental, statistical and dynamical meteorology and forecasting.

M. MAURICE MAETERLINCK, who last year received the Nobel prize for literature, proposes to raise the sum to \$40,000, and to employ it to establish a biennial prize of \$3,200 to be awarded to the author of the most remarkable work—whether on literature, art or science—published in the French language.

SIR WILLIAM RAMSAY, for twenty-five years professor of chemistry at London University, has submitted his resignation, and the senate has resolved: "That the senate accept Sir William Ramsay's resignation with sincere regret, and desire to express to him their high appreciation of the services which he has rendered to the university both by his inspiring work as a teacher and by the great series of researches carried out by him at University College during his tenure of the chair of chemistry."

PROFESSOR RUBNER, director of the Berlin Hygienic Institute, has received the large gold Rinecker medal of the University of Würzburg.

We learn from *Nature* that the Rhodesia Scientific Association's gold medal, recently

offered for an original paper advancing the knowledge of the transmission of any insect or arachnid-borne disease affecting Rhodesia, has been awarded to Dr. Edward Hindle, Beit memorial research fellow, for his paper on "The Transmission of *Spirochæta duttoni*."

At the January meeting of the Chicago Academy of Sciences the following officers were elected: *President*, Dr. T. C. Chamberlin; *First Vice-president*, Professor C. B. Atwell; *Second Vice-president*, Dr. Henry C. Cowles; *Secretary*, Dr. Wallace W. Atwood.

DR. ANGEL GALLARDS, biologist, has been appointed director of the Museo Nacional, Buenos Aires, in the place of the late Professor Florentino Ameghino.

DR. FREDERIC A. LUCAS, director, has been appointed to represent the American Museum of Natural History at the Centenary of the Academy of Natural Sciences of Philadelphia, March 19-21, 1912. Dr. W. D. Matthew, curator of the department of vertebrate paleontology, has been appointed to represent the museum at the celebration of the one hundred and twenty-fifth anniversary of the University of Pittsburgh, February 27-29, 1912.

MR. FREDERIC G. HALLETT, secretary to the examining board of the Royal Colleges of Physicians and Surgeons, has left London for the United States, having been invited by the council on medical education of the American Medical Association to attend the conference on medical education to be held in Chicago on February 26, and to address the meeting on the subject of the methods of conducting examinations for licenses to practice medicine adopted by the conjoint examining board in England.

THE University of Michigan has granted a leave of absence to Professor William H. Hobbs for the academic year 1912-13. In his absence from the university, the charge of the department of geology will devolve upon Professor E. C. Case. Professor Hobbs's classes in geology will be conducted by Professor Frank Carney, head of the department of geology at Denison University. Professor

Hobbs will devote the year to study and travel abroad.

THE yacht *Anton Dohrn*, of the department of marine biology of the Carnegie Institution of Washington, will make a cruise to Andros Island, Bahamas, in April and May, the chief objects being to provide an opportunity for Dr. T. Wayland Vaughan to continue his studies upon coral reefs, and to permit G. Harold Drew, Esq., B.A., of Cambridge University, to pursue his researches upon the denitrifying bacteria of tropical seas. Dr. Paul Bartsch will also study the ecology of the molluscan fauna, and trawls with self-closing nets will be made in the deep tongue of the ocean.

THE third Hamilton fund lecture of the Smithsonian Institution was delivered by Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research, in the auditorium of the U. S. National Museum on February 8. The title of the lecture was "Infection and Recovery from Infection."

DR. R. M. PEARCE, professor of research medicine in the University of Pennsylvania, gave a course of five lectures on the Hitchcock foundation, at the University of California from January 22 to 26. The subjects of the lectures were as follows: "Antiquity to 1800—The Efforts of Isolated Investigators," "The Development of Laboratories for the Medical Sciences," "Pasteur and the Rise of Bacteriology," "Present Day Methods and Problems," "Medical Research in American Universities, Present Facilities, Needs and Opportunities."

THE Ichabod Spencer foundation lectures are being given at Union College by Professor Hugo Münsterberg, of Harvard University. His subject is "Applied Psychology."

At a recent meeting of the Biological Science Club, of Oberlin College, Professor L. James, associate professor of animal ecology, gave an address covering some phases of his special research work upon the migration of birds, carried on during the summer at Pt. Pelee, Lake Erie.

MR. CALVIN W. RICE, secretary of the American Society of Mechanical Engineers, was the guest of the student branch of the society in the College of Engineering of the University of Illinois on January 23 and 24. In an address before the members of the society, Mr. Rice emphasized the importance of every engineer being interested in the national engineering societies. Mr. Rice was entertained by the local members of the society at a dinner at the University Club in the evening of the 23d.

PROFESSOR E. H. S. BAILEY, director of the chemical laboratories in the University of Kansas, has been granted a leave of absence for the remainder of the school year 1911-12, and will leave immediately for Europe, where he will make a study of foods, investigating market conditions and food supplies.

UNIVERSITY AND EDUCATIONAL NEWS

GIFTS, aggregating \$81,291, have been announced by the trustees of Columbia University including \$30,000 from Dr. William H. Nichols for instruction and research laboratories in chemistry; \$25,000 from Mrs. Russell Sage, for the E. G. Janeway Library endowment fund at the medical school; \$15,000 from W. Bayard Cutting, to establish the William Bayard Cutting, Jr., fellowship in international law, and \$10,000 from Augustus Schermerhorn, to be expended for the current needs of the university. Dr. Theodore C. Janeway has given to the trustees the medical library left to him by his father, Dr. Edward G. Janeway.

THE completion of the half million endowment fund for Oberlin College has made possible the following additions to the college resources: the men's building, \$150,000; a new administration building, \$50,000; the completion of the men's gymnasium, \$30,000; a part payment on Keep Cottage, the new women's dormitory, of \$10,000; for higher salaries, \$200,000, and other endowments, \$60,000; thus making a total of \$240,000 for buildings and \$260,000 for salaries and other endowments. Among the donors were the following: anonymous, \$200,000; a friend, \$50,-

000; Dr. L. C. Warner, of New York City, \$40,000; Mr. and Mrs. G. N. Clark, of Evanston, Ill., \$10,000; Charles M. Hall, of Niagara Falls, N. Y., \$10,000; an eastern friend, \$12,000; Mrs. D. Willis James, of New York City, \$10,000.

TRANSYLVANIA UNIVERSITY has announced that the effort to raise a fund of \$250,000 has been successfully completed. The largest gifts aside from \$50,000 offered by the General Education Board in May, 1910, were as follows: \$30,000 from R. A. Long, of Kansas City; three gifts of \$15,000 each from W. P. Bowers, of Muncie, Ind., Geo. H. Waters, of Pomona, Calif., and J. J. Atkins, of Elkton, Ky.; \$9,000 from M. F. Pearce, of Covington, Ky., and four gifts of \$5,000 each. The remainder of the fund was provided in many smaller amounts.

CONTRACTS have been let for the erection of a new laboratory of mining engineering and a new ceramics building at the University of Illinois. Two other buildings, the commercial and the woman's building, are being constructed and plans are nearly completed for a new armory, stock pavilion and transportation building.

At a recent meeting of the court of the Goldsmiths' Company the following grants were made to the senate of the University of London: For the building fund of King's College for Women, £10,000; for the endowment fund of Bedford College for Women, £5,000; for the building and equipment fund of the chemical department of University College, Gower Street, £1,000. The company has also made a grant of £1,000 to the National Physical Laboratory at Teddington for the equipment of the metallurgical department at that institution.

DR. ROBERT DAVIES ROBERTS, secretary of the Congress of the Universities of the Empire and chairman of the executive committee of the University of Wales, who died on November 14, aged 60, left an ultimate residue legacy to the University College of Wales at Aberystwith, to form the nucleus of a fund "to enable professors after a certain number

of years of service, say not less than ten, to be released from the professorial duties for a period of about a year, and, at any rate, not less than six months on full salary, a substitute being paid out of the income of the fund; the purpose of this release from college duties being to enable the professor to refresh his mind by travel or research or visits to other universities, and so gain fresh stimulus and equipment for his work."

THE University of Pittsburgh will celebrate its one hundred and twenty-fifth anniversary on February 27, 28 and 29, 1912. The first charter was granted to the Pittsburgh Academy on February 27, 1787. In 1819 it became the Western University of Pennsylvania, the name being again changed in 1908 to the University of Pittsburgh. Educational conferences will be held on Tuesday, February 27. On Wednesday, February 28, an historical address on "The Progress of Higher Education since 1787" will be given by Chancellor Kirkland, of Vanderbilt University. This address will be followed by the conferring of honorary degrees. In the afternoon an historical address on the University of Pittsburgh will be given by former Chancellor Holland, followed by addresses by representatives of educational institutions. On Thursday, February 29, there will be conferences of the college presidents of Pennsylvania and secondary schools of western Pennsylvania. The visiting guests will be entertained at luncheon on each day of the anniversary celebration and at the alumni anniversary banquet on Wednesday evening.

By vote of the faculty of Oberlin College, the budget for the current year contains a special appropriation to be used in defraying the expenses of administrative officers, professors and associate professors who wish to attend meetings of scientific societies and other gatherings of a professional nature. The faculty is divided into ten groups, and each has a proportionate share in the general fund.

THE inauguration of President Hibben of Princeton University will take place on the morning of Saturday, May 11.

FATHER ALEXANDER J. BURROWES, S.J., a native St. Louisian and now the head of Loyola University, has been elected president of St. Louis University, succeeding Father G. P. Frieden, S.J., who died suddenly two months ago.

DISCUSSION AND CORRESPONDENCE

PROFESSOR JENNINGS AS A BIOLOGICAL PHILOSOPHER

NOT for many a day, according to my notion, has anything more significant taken place in the biological realm than Professor Jennings's presidential address on "Heredity and Personality" before the American Society of Naturalists at its recent meeting (SCIENCE, December 29, 1911).

How splendid an era of biological achievement will have been ushered in when men of Jennings's rank shall come forth from their laboratories upon occasion and discuss, without feeling the need of apology for doing so, the infinitely large as well as the infinitely small problems of our science! This address augurs for Jennings as commanding a place in the larger biology as he now holds in the smaller.

Concerning the particular road, namely, that of genetics, by which Professor Jennings has come so near the edge of the woods of biological minutism I shall say little at this time. Rather it is about his rôle as philosopher, or better as metaphysician, that I wish to speak. In the first place I want to express my gratification at the clear evidence furnished by this address particularly, that he possesses both the aptitude and the courage to be the successor of Brooks, not merely as a professor of zoology but as an upholder of the rights and dignity of the philosophical side of biology. In the second place I am going to claim the privilege usually accorded to seniority of years and counsel Jennings against the supposed necessity of apologizing for the violation of good biological manners when he yields to his inclination to talk to fellow biologists on large subjects.

Now as to the problems raised. I do not, as already said, propose to go far into the sub-

ject matter of these at present. My chief wish is to point out what, as I see them, they are historically; and to state in language not primarily biological, but rather psychological and logical, what I conceive to be the central one among them.

When the man who is a biologist comes, as he sooner or later must come, upon the problems of the "I," the "not-I," the "self," "personality," "potentiality," and the rest, he is doomed to almost complete failure in his attempt to deal with them unless he supplements, whole-heartedly and with much pains, the methods to which he is accustomed in his usual field and laboratory researches by at least some of the methods of the introspective psychologist, the logician and the metaphysician. The main reason why this is so is that our senses and our minds are just as truly instruments of research—parts of our laboratory equipment—as are our microscopes, our mother tongue, and our mathematical formulae. Consequently to neglect to inform ourselves somewhat as to the principles of construction and mode of working of these personal instruments is to be mere rule-of-thumb workmen, just as similar neglect of the principles underlying our microscopes and language and mathematical formulae would make us rule-of-thumb users of these means of research. The biologist who has given no attention to the way sense perception, and imagination, and rational process enter into a laboratory investigation has no more claim to be considered a genuinely scientific biologist than has a druggist's clerk to be considered a genuinely scientific chemist.

When one passes beyond the state of the raw empiricist in the use of his personal tools of research he soon comes upon the retinue of questions raised by Professor Jennings, and finds himself face to face with such live historical questions as that of the meaning of *radical empiricism*; as that of what the real kernel of *psycho-physics* is; as that of what is actually at the bottom of the conception of "*things-in-themselves*," of Berkeley's *esse est percipi*, of Descartes's

famous *cogito dictum*, of the Schoolmen's endless troubles about *matter* and *form*, *substance* and *accident*, of the early Church Fathers' warrings over the *Logos* and the *Trinity*, of Plato's *Ideas*, of the Chinese Buddhist's *Bodhisattva*, of the Vedic poet's *deva* and *vasu*, of the Melanesian's *Mana* and of innumerable other words and phrases found wherever the deeper instincts and desires and strivings of human beings have found expression in terms that mean any thing at all to other human beings. Vital knowledge of these matters does not imply vast learning. In these days when books on all subjects under heaven are almost as abundant and accessible as the leaves on the trees nothing is requisite to make every educated person informed in these regions beyond the recognition of how vital such knowledge is, and industry, economy and discrimination in the use of his time.

So much for the historical setting of the problems. Now a little as to what, substantively, the central one among them is. It is the two-fold problem as to just how all knowledge of nature, be it ordinary or scientific, is built up, and whether there is any knowledge whatever that does not contain, on the one hand, essential elements of sense perception, and, on the other hand, essential elements that can not be derived from sense perception, but have their seat at deeper depths than sense.

All I am going to say toward an answer to this question is this: If Professor Jennings will tackle again his exceedingly interesting questions of how long a "pure line" may be, and how many knots there are in the web of organic existence, starting this time from the standpoint of the "standardized reality" suggested by me a few years ago,¹ and will work at it as devotedly as he does at problems of animal behavior and genetics, he will find no more possibility of getting into the limbo he seems to be in over reincarnation than of getting ensnared in the problem of whether there is anywhere in the universe a place in which *cubes are spherical in shape*. To be

¹"Life from a Biologist's Standpoint," *Popular Science Monthly*, August, 1909, p. 180.

more specific, he will find that in his phrase "If . . . I am a redevelopment of the characteristics of some former individual from a piece of his body," the words "I" and the group of words "characteristic of some former individual" exactly cancel each other and leave an intellectual blank, just as do the words "cubical" and "spherical" when the attempt is made to apply them to one and the same body. That is to say, despite the splendid combination of breadth of outlook and ability as a laboratory methodologist and technician which distinguishes Jennings as a biologist, his address at this point is subject to the same miscarriage of reason that has characterized nearly all modern speculative thinking on the Mendelian type of inheritance. The miscarriage to which I refer arises from neglecting the technical detail of noticing that since there always is a strictly psychological or subjective element in the idea expressed by the term "characteristic," it comes about that the very construction of the sense-perceptual aspect of our knowledge is such as to make it utterly impossible for the truly *same* characteristic to belong to more than one body. This fundamental truth has been overlooked in speculative biology largely, I suspect, from failure to note that so far as the subjective side of perception is concerned, "characteristic" is exactly synonymous with "quality" and "property." Bearing this fact in mind, the situation clears up readily when we turn to the familiar practical (not, generally, the theoretical) language of chemistry. The working chemist never for an instant thinks of trying to express or "explain" the characteristics, or properties of hydrogen in "terms of" the characteristics of oxygen, for he knows perfectly well that were he able to do such a thing there would be no such gas as hydrogen, for all hydrogen would be oxygen. There is no doubt in the world, as one sees if he looks at the case closely, that most of the recent effort to "explain" the adult organism in terms of the germ cells has involved just the self-destructive fallacy that the chemist would be a victim of were he to try to explain

hydrogen in terms of oxygen. The fact that the adult organism develops from the germ cells while oxygen does not, so far as we know, develop from hydrogen, does not in the least affect the psychological fact that the adult is known by its own characteristics and in no other way, exactly as the germ cell is known by its characteristics and in no other way.

Once one sees clearly that this aspect of the problem of genetics differs *toto celo* from the problem of developmental potentiality, that is, the problem of how the germ cell is able to develop into the adult, he has gone a very long way toward a consistent, workable philosophy of biology.

In Jennings's sentence "if the phrase 'potential immortality' means anything for the infusorian, it means exactly the same for me, so far as we can judge from past history," I find encouragement for the hope that he will be willing to give my principle of standardization a good testing.

WM. E. RITTER

MARINE BIOLOGICAL STATION OF SAN DIEGO,
LA JOLLA, CALIFORNIA,
January 4, 1912

THE CHESTNUT TREE DISEASE

TO THE EDITOR OF SCIENCE: In connection with the chestnut tree disease mentioned in SCIENCE of December 29, 1911, and in preceding numbers, the writer calls attention to the hardy giant chinquapin (*Castanopsis Chrysophylla*) of the Pacific states. This may be a resistant species adaptable to the southern states. It occurs in two varieties, the one just mentioned and a dwarfed variety. The former reaches a height of 120 feet and has a diameter of from 8 to 10 feet; ordinarily from 40 to 55 feet in height and from 1 to 2 feet in diameter. Locality, near Willets in Mendocino County, Cal. The dwarfed form is abundant in the Cascade and Sierra Nevada and San Jacinto mountains from 2,000 to 9,000 feet. It is mostly of shrubby habit, but to all appearances identical with the giant chinquapin. This latter is a hardy and long-lived evergreen of stately and handsome

form. The timber is suitable for many purposes, saws readily, is fine grained and light brown. The burr and nut of both varieties are almost identical in size and appearance with the eastern chinquapin. They are difficult to obtain and are frequently attacked by a small whitish worm, the egg of which is deposited, as in the eastern chinquapin and chestnut, by a moth.

The writer suggests that the giant chinquapin be experimented with as a possible resistant species to reforest the eastern states devastated by the chestnut tree disease. The tree would probably stand the eastern conditions south of Maryland. The shrub is extremely hardy.

MARSDEN MANSON

SAN FRANCISCO, CAL.,

January 8, 1912

AN UNUSUAL EFFECT OF A LIGHTNING DISCHARGE

THE following note made by the writer under date of July 18, 1911, may be of interest: On the land of J. M. Dunklee (of Hawes postoffice, Ark.), in the N.E. $\frac{1}{4}$ of the N.E. $\frac{1}{4}$ of Sec. 11, T. 2 S., R. 20 W., the lightning struck an oak tree (according to Mr. Dunklee three years ago), much shattering it. The tree stood near the top of a sandstone ridge. The discharge passed to the roots of the tree, then followed in the ground down the north slope, tearing out a trench in places 3 feet wide, and which must at first have been $2\frac{1}{2}$ feet deep. At this time, the depth is $1\frac{1}{2}$ feet. The discharge followed down the slope 50 feet, tearing up the sandstone and throwing one block that is estimated to weigh 1,200 pounds up into the air and out of the trench. At the lower end of the trench, the discharge apparently passed beneath the surface, along a bedding plane between the upturned layers of sandstone. There is no evidence of any fusion of the rocks or the soil.

A. H. PURDUE

FAYETTEVILLE, ARK.,

January 10, 1912

"MISUSE OF THE TERM 'GENOTYPE'."

TO THE EDITOR OF SCIENCE: If the distinguished students of genetics whose communi-

cations have recently appeared in your pages do not imagine that their work is of interest to biologists and naturalists at large, then one is entitled to question their claim to so much of your space. Let them, one might say, confine their "terminological inexactitudes" to their own technical periodicals. If, however, they believe, as I do, that their highly valuable work should appeal to all biologists, and that it has a particularly important bearing on the methods and conclusions of the systematist, then surely they should try to avoid the use of terms that are liable to mislead the general naturalist, and that sooner or later must clash with those of the taxonomic biologist. But assuming that they persist in acting as though their work were either unworthy of general attention or far above the heads of all outside their charmed circle, still may one not appeal to them to recognize that serious writers in SCIENCE are at any rate their scientific colleagues, and as such have a claim to be treated with ordinary courtesy? To state, after what has been written, that Dr. Johannsen is the "originator of the word genotype" is to give either the cut direct or the lie direct to a fellow-worker.

F. A. BATHER

LONDON, ENGLAND,

January 17, 1912

SCIENTIFIC BOOKS

The Animals and Man. An Elementary Text-book of Zoology and Human Physiology. By VERNON LYMAN KELLOGG. New York, Henry Holt and Company. Pp. 495.

The present trend in high schools toward a combined course in human physiology and zoology is calling forth its inevitable train of new text-books, of which the present volume by Professor Kellogg is one. Knowing the writer's practise in text-book preparation and his wide experience as a teacher and a zoologist, one is justified in looking for something exceptional in this new effort, but the reviewer must confess to a feeling of disappointment on reading the book. It has the appearance of having been hastily constructed with a somewhat too liberal use of scissors and paste on

the author's earlier text-books. The section on human physiology (chapters XXI-XXVIII), by Miss McCracken, while interesting enough in itself as an abridged elementary account of human anatomy and physiology, stands almost wholly unrelated to the rest of the text. To the reviewer, the present need seems rather to be for a text-book of zoology so thoroughly permeated with physiological interpretations and applications that the zoology and physiology become a unit throughout the entire work. However, beyond the question of arrangement of material—a matter which will doubtless always remain largely one of individual opinion—the over-plentiful sprinkling of errors throughout the book lays it open to more serious criticism. For example, on page 32 in a description of the crayfish we read that "In the female the genital pores are in the basal segments of the next to the last pair of legs." On the same page *ligaments* are spoken of when *tendons* are meant, the digestive gland is described as yellow whereas it is characteristically reddish or greenish in color, and *four* pairs of ostia (a dorsal, two lateral and one ventral pair) opening into the heart are called for. On page 35 occurs a questionable usage of the term *ureters*. Again, in the light of recent investigations, we doubt if the statocyst of the crayfish is very generally "believed to be an auditory organ" (pp. 30, 74). On the same page one reads that "the longer pair of appendages are the antennæ and the sense of smell is believed to be located in the fine hair-like projections upon the joints." As a matter of fact, certain peculiar club-shaped organs on the outer ramus of the *antennules* have generally been considered the chief olfactory end-organs. Recent researches of Holmes and Homuth confirm this but show that other parts of the body (mouth parts, tip of chelipeds, inner ramus of antennules and the antennæ) are also sensitive to olfactory stimuli. On page 41 we find this astonishing statement in an account of conjugation in *Paramœcia*, "... part of the macronucleus and micronucleus of each passes over to the other, and

the mixed elements fuse together to form a new macro- and micronucleus in each half." In view of the wonderfully adapted mechanism in the amphibian heart for keeping the "pure" and "impure" blood at least approximately separated, the statement regarding the ventricle of the toad (p. 23) that "here the pure and impure blood are mixed," might well be qualified somewhat. On pages 14 and 15 *quill feathers* and *contour feathers* are set apart as two contrasting groups. On page 47 occurs the statement that "in addition to the proteids protoplasm usually contains native albumins," etc.; native albumins, of course, being proteins. Throughout the book the word *proteid* is used instead of the preferable *protein*. On page 100, speaking of the pairs of legs, the statement is made that "the order of their appearance differs in the toad tadpole and the frog tadpole." One is led to suspect that the author had in mind rather anuran and urodele tadpoles respectively. On page 153 we are inaccurately informed that "hermit crabs all have the habit of carrying about with them, as a protective covering into which to withdraw, the spiral shell of some gastropod mollusc," and in the same paragraph, speaking of the abdomen of the hermit crab, occurs the statement that "it has on it no legs or appendages except a pair for the hindmost segment, which are modified into hooks for holding fast to the interior of the shell." As a matter of fact while generally absent from the right side of the abdomen (except on the sixth somite), the pleopods of the left side, though often much reduced, are present, and in the female are used for the attachment of the eggs. On page 154 in speaking of the acorn barnacles the "six calcareous plates" mentioned are characteristic of the family *Hexameridae* only and not of all "acorn barnacles." On page 170 we are told that "the cuttlefishes and octopoi have no foot," but on page 178 that "the decapods, as their name indicates, have ten feet or arms," etc. Aside from this contradiction in statement, the high school student might pertinently inquire what the

name *Cephalopoda* indicates. On page 191 it is stated that "nearly all the Chordata are marked by the presence, either in embryonic or larval stages only, or else persisting throughout life, of a number of slits or clefts in the walls of the pharynx which serve for breathing, and which are called gill-slits." Do not *all* Chordata have gill-clefts at some stage of their life history? Again, on page 201 one reads the too inclusive statement that "all batrachians breathe by means of gills for a longer or shorter time after birth." On page 256, hyenas are classified as *Felidæ*. On page 337 we are informed that muscles are the active organs of motion and locomotion in all animals.

In the physiological section there is an obvious attempt to "write down" to the audience and the result is frequently anything but happy. For instance one meets not infrequently with such apparently significant though actually meaningless statements as (p. 291) "the most necessary element in all the world is oxygen." On page 294 one encounters the rather astonishing bit of information that "muscle is largely a compound of sulphur and other elements." On page 316 we read that "it is the function of hæmoglobin to carry oxygen to the tissues and carbon dioxide from the tissues," a statement which, to say the least, is misleading, in that as regards carbon dioxide, the carrying power of hæmoglobin is at most of minor importance. On page 340 heart muscle is classified as non-striated. On page 291 we encounter the obscure and in part erroneous statement that "carbohydrates contain carbon, hydrogen and oxygen, the former predominating. Fats contain also chiefly oxygen, carbon and hydrogen, the latter predominating." On page 296 under "Tests for Proteids" what is probably the most universal and certain test of all, the biuret reaction, is omitted. On page 301 referring to alcohol we find this remarkable piece of information—remarkable both in point of fact and of rhetorical climax—"unlike other poisons its use establishes a craving or appetite for it which eventually

weakens the will and is apt to lead to intoxication." How *unlike* cocaine, opium, morphine, etc., is it in this cumulative effect? On page 311 we learn that "the mesentery is fastened at the back to the spinal column." On page 363 instead of using axon and axis cylinder as synonymous terms the axis cylinder is spoken of as a central fiber of the axon. On page 317 the term *fibrin* is misused.

A careful reading of the text discloses a considerable number of little inaccuracies, mainly in the way of too inclusive statements, but space will not permit of specific citation. Some of these may perhaps be excusable on the basis of being well-nigh unavoidable in an elementary book where confusion of ideas must be avoided, but in not a few instances a single qualifying word would have set the matter right.

While the reviewer has found it necessary to devote most of his space to pointing out errors, he does not wish to leave the impression that the book is without merit. On the contrary, it has many excellencies. The subject-matter is well chosen, the general descriptive treatment is for the most part excellent and interestingly written and the text covers a wide range of timely topics in addition to the more formal zoological work.

M. F. GUYER

UNIVERSITY OF WISCONSIN

A FEW BOOKS ON AERONAUTICS

A NEW science and a new industry, a new sport and a new mode of warfare have come upon us with such startling suddenness that many are clamoring to know how it all came about; while authors are tumbling over each other—many over the facts and even over their English too—in a mad rush to tell the story, the story of aeronautics that only a master can tell.

The following are a few of the 1911 versions of this story.

Aerial Locomotion. By E. H. HARPER and ALLEN FERGUSON. Cambridge University Press, XII., 164, price 1 shilling.

This little book is so clearly written that it

can be understood by the average boy, and yet it explains many facts that often are either wholly ignored or, for the average reader, told only in unintelligible symbols and signs.

For the non-mathematical reader, and for the man who does not care for a large volume on the subject, this probably is one of the best books available.

The Aeroplane. By T. O'B. HUBBARD, J. H. LEDEBOER and C. C. TURNER. Longmans, Green and Co., X., 127, price 2 shillings 6 pence.

There is an old proverb to the effect that "too many cooks spoil the broth," and it seems to be eminently applicable in the present case.

The first chapter deals with the properties of the air, and is so full of errors that it would take another chapter to correct them. A simple example will suffice:

Now the density of water-vapor is 0.623 of that of air, and since air can contain a portion of water-vapor amounting to 3 per cent. of its volume, it is obvious that saturated air is lighter than dry air.

This statement would be pretty hard to beat in a contest for number of errors in a single sentence. One had as well say that since a sponge can contain water that therefore a saturated sponge is lighter than a dry one.

As a matter of fact moist air is lighter than dry air at the same temperature and pressure, but the authors have not explained the correct reason.

The rest of the book, after the first chapter, is fairly good for the popular reader and has the excellent feature of conspicuous division into topics, but it is marred here and there by the presentation of rough approximations in the guise of exact values.

Bird Flight as the Basis of Aviation. By OTTO LILIENTHAL. Longmans, Green and Co., XXIV., 142.

This of course is a translation of an old and well-known German book. But the translation was worth while, since it enables a larger number of persons to read for themselves Lilienthal's accounts of numerous ex-

periments based upon careful studies of birds and their mode of flight. It is astonishing how many experiments he and his brother made, and what generally well-founded conclusions they reached. Otto Lilienthal was one of the enthusiastic pioneers in the experimental study of aviation and his work undoubtedly contributed materially to the final accomplishment of mechanical flight, albeit along lines different from those he believed the most practicable. He believed that nature's method is always the best method—forgetting, possibly, that the locomotive, though swifter than the greyhound, runs on wheels and not on legs—and so he strove to fly, as do the birds, with beating wings and soaring.

Soaring, at least, is greatly to be desired, and likely some day to be fully achieved, and so this book, by one of the most enthusiastic advocates of bird flight, still has a freshness about it and much of interest; in fact it is one of the few aviation classics.

Monoplanes and Biplanes. By G. C. LOENING. Munn and Co., New York, XIV., 331, price \$2.50.

This book is not adapted to the taste of the general reader—it is neither poetry nor romance—but to the man who is seriously studying aeronautics and needs to know how the various types of aeroplanes are made it is well nigh invaluable.

It begins with a short but appreciative account of the work of Langley, Lilienthal and Chanute. This is followed by several excellent chapters on air resistances and air friction, with numerical examples applicable to aeroplane designing.

After this, various types of aeroplanes, 18 monoplanes and 20 biplanes, are described in detail and intercompared. A separate chapter is devoted to the different types of controlling apparatus, and another timely and sensible chapter, to accidents and their various causes.

Every chapter is profusely illustrated, and in the great majority of cases the illustrations are extremely helpful to the reader. There also are numerous references to original articles which may be consulted by those who wish more detailed information.

In a new edition pages 18, 19 and 20, in so far as they discuss air density, might be slightly modified to advantage. Here "air holes" are spoken of as places of low air density.

An aeroplane entering one of these low density regions from the air of higher density around it, will suddenly fall without any warning, merely because the pressure has enormously decreased, and the aeroplane has not had time to attain the requisite velocity of support in this lighter medium.

Enormous differences in pressure must cause enormous changes in the barometer, but such sudden changes are never found in the open, and, besides, it can be shown that the movement (whirl) of the atmosphere necessary to produce a change of pressure amounting to one tenth of the total would be of most destructive violence.

But this is a small fault to find with a book so generally helpful.

Elementary Aeronautics. By ALBERT P. THURSTON. Whittaker and Co., 126.

This is a non-mathematical but clearly written account of the action of air upon moving surfaces, plane and curved, and the application of these principles in the design and operation of aeroplanes.

While both elementary and brief, it seems to be free from errors, and can be recommended to those who wish some reliable information about the general action of aeroplanes, but have not the time to make a real study of them. W. J. HUMPHREYS

A Manual of Philippine Silk Culture. By CHARLES S. BANKS, Department of the Interior, Bureau of Science, Manila, 1911.

Mr. Banks has been engaged, among his other duties, in a study of the possibilities in the way of profitable silk culture in the Philippines ever since the Bureau of Science was started, and this manual puts into convenient shape the results of his investigations. It is a royal octavo pamphlet of about fifty pages, with 18 good halftone plates and diagrams of rearing house and reel. He gives directions for the care of the domestic mulberry silkworm, and announces a cross between the Ben-

gal-Ceylon and Japanese silkworms which he terms "the Philippine race of silkworms." He also announces the successful introduction of the Eri or Castor silkworm (*Attacus ricini* Bois.) from Ceylon. He thinks that the silk produced from this insect will be popular not only among the Christian Filipinos, but also among the mountain tribes and the Moros, and further that it will find a sale among the Americans and Europeans for hangings, upholstery and even for heavy dress goods. He concludes that, with both the mulberry and the Eri silkworms, the industry can be carried on in the Philippines under conditions as favorable as those which obtain in the best silk-producing countries in the world, with the added advantage that no disease has appeared as yet. That every effort is being made to prevent the introduction of disease is shown by the act of August 14, 1907, prohibiting the importation of silkworms, either eggs or cocoons, into the Philippine Islands except by the Bureau of Science.

L. O. H.

SPECIAL ARTICLES

FOSSIL HOLOTHURIANS

Few classes of animals have a less satisfactory geological record than the holothurians and every fragment that can be gathered is therefore of unusual interest and importance. The known records occur in two forms, impressions of the whole animal or much more commonly, nearly or quite microscopic calcareous particles imbedded in fine shales and limestones and resembling more or less nearly the similar calcareous particles found in the body-wall of most living holothurians. Ludwig¹ has well summed up the phylogenetic value of these fossil particles:

Solche Reste aus dem Kohlenkalk, dem Jura, der Kreide und dem Tertiär vorliegen, aber keine sichere Bestimmung nach Art, Gattung und Familie gestatten: nur die eocänen Synaptidenreste . . . machen davon eine Ausnahme, da sie sich mit einiger Sicherheit auf die Gattungen Synapta, Chiridota (oder Trochodota) und Myriotrochus beziehen lassen.

¹ 1892, "Die Seewalzen," p. 446.

If then we are to secure satisfactory paleontological knowledge of the history of holothurians, we must look for it in the impressions (or possibly casts) of the entire animal. As yet evidence of this sort is very rare and highly unsatisfactory. Rüppell¹ long ago described what he thought was a fossil holothurian from the Solenhofen limestone but there is little about either his description or figure that warrants his conclusion. Zittel² suggested that the object might perhaps be a cephalopod, but that is also little more than a guess. Giebel³ has given an account, accompanied by three good figures, of fossils from the same limestones for which he proposed a genus "Protholothuria." Zittel (*l. c.*) refers casually to this genus but considers the specimens "problematische Körper." Probably he was not familiar with the appearance of living holothurians, particularly when eviscerating; otherwise it is hard to see why he was so doubtful about Giebel's specimens. Ludwig (*l. c.*) quotes Zittel but apparently without having examined Giebel's figures, which are deserving of careful consideration. Study of these figures and their accompanying text has satisfied me that the objects really are the impressions or casts of holothurians. Giebel found calcareous particles in the outer body layer (or on the surface of the object), thus confirming the impression made by the striking resemblance of the outline and surface, to contracted specimens of the smaller species of Holothuria. It seems to be impossible, however, to point out any characters by which "Protholothuria" may be distinguished from Holothuria and the name is no doubt a synonym, but it is odd that it is not listed in Scudder's Index (either as Protholothuria, Proholothuria or Protoholothuria) nor in the later generic lists of the "Zoological Record." Even Spandel and other writers on fossil holothurian remains seem to have overlooked or

forgotten Giebel's work. Simonelli⁴ figures a peculiar fossil, *Lorenzinia*, which he suggests may be part of a holothurian allied to *Pelagothuria*. The material is such that no real identification is possible and the probability of its having anything to do with holothurians is very remote.

The Solenhofen specimens of Giebel therefore appear to be the only fossil holothurians known (not counting, of course, isolated calcareous particles) and obviously their phylogenetic value is slight, as they simply show that holothurians apparently like those of the present day existed in the Jurassic Seas. It was, therefore, a matter of extraordinary interest when Dr. Walcott recently announced the discovery of a notably diversified holothurian fauna in the Middle Cambrian rocks of British Columbia.⁵ Through the greatly appreciated courtesy of Dr. Walcott and the kindly assistance of Mr. Austin H. Clark, I have recently had the privilege of examining the material upon which this report is based and I will say at once that Dr. Walcott's published figures leave almost nothing to be desired. Excepting only two specimens, examination of the originals showed nothing not revealed by the figures and equally important is the fact that the figures show nothing which is not equally distinct in the specimens. This is most satisfactory, as it will enable any one familiar with the fundamental characteristics of the class to form an intelligent opinion as to whether Dr. Walcott's fossils represent holothurians or not. The two cases in which I have taken exception to the figures are found on plates ten and thirteen. In Figure 1, Plate 10, the illustration does not quite do justice to the specimen; the knobs shown above the central ring (*CR*) are more distinct in the specimen, two of them showing not only definite outlines but some indications of their structure. In Figure 2, Plate 13, on the other hand, the terminal mouth

² 1829, "Abbildung und Beschreibung einiger . . . Versteinerungen . . . von Solenhofen."

³ 1876-80, "Handbuch der Paläontologie," Bd. 1, Abt. 1.

⁴ 1857, *Zeitsch. f. die Gesammten Naturw.*, Bd. IX., pp. 385-388.

⁵ 1906, *Bologna Mem. Acc. Sc.*, 1905, series 6, Vol. 2, pp. 263-268.

⁶ 1911, "Cambrian Geology and Palaeontology," II., No. 3, Middle Cambrian Holothurians and Medusæ, *Smithsonian Misc. Coll.*, Vol. 57, No. 3.

surrounded by a jointed or notched ring is distinctly shown; in the specimen, I was unable to make out these points satisfactorily; there seems little doubt about the terminal mouth, but the surrounding ring is ill-defined and I failed to see the joints.

Dr. Walcott names and describes four genera, each with a single species, of what he believes to be holothurians. He apparently has not seen Giebel's figures for he says (p. 42) that his specimens record "for the first time, with the exception of some scattered calcareous spicules and plates, the presence of this class of organisms in any geological formation." That he feels no serious doubts as to the fossils being holothurians is shown by the statement (p. 43) that they establish "the very ancient origin of the Class Holothurioidea and the fact of its great differentiation in Middle Cambrian time," and the assertion (p. 45) that "The Holothuriidæ is represented by *Laggania cambria* and *Louisella pedunculata* and the Synaptidæ by *Mackenzia costalis*. The Pelagothuridæ is indirectly represented by *Eldonia ludwigi*." It is not clear what is meant by the Pelagothuridæ being "indirectly represented" by *Eldonia* since that genus is subsequently made the foundation of a new family, the Eldoniidæ, especially as Dr. Walcott later shows that his new genus has almost nothing in common with Pelagothuria.

The material upon which *Eldonia* is based is abundant and much of it seems to be very well preserved, but of *Laggania* and *Louisella* there are single specimens only, while of *Mackenzia* there are but two specimens and they differ from each other greatly. Of *Laggania*, Dr. Walcott says the mouth was "ventral, near the anterior end and surrounded by a ring of plates." "It is not practicable to make out the arrangement of the plate-like structure surrounding the mouth, as the calcareous plates, if ever present, have disappeared." "Traces of tube-feet occur on the ventral surface" but "the body of the animal is so completely flattened that the tube-feet are obscured." I have sought in vain both in the figure and on the specimen for anything that could be called a tube-foot, without an exces-

sive use of the imagination. Moreover the "ring of plates" surrounding the mouth does not remind one of the calcareous ring of a holothurian, but it does suggest to me the radiating folds surrounding the partially contracted oral disk of certain actinians and worms. Dr. Walcott calls attention to the surface markings of "indistinct concentric bands, each one of which is crossed by fine longitudinal lines." This can be easily seen in the figure (at least in certain spots) with the aid of a lens. I do not recall any holothurian with such a surface, but it is suggestive of certain worms, and even some actinians have a somewhat similar exterior. On the whole it does not seem to me that *Laggania* can be positively assigned to any invertebrate phylum. I see nothing beyond the probable form of the body, and the terminal mouth, to suggest a holothurian, and these characters are equally suggestive of actinians.

The specimen of *Louisella* seems to show more structure and Dr. Walcott says of it:

With numerous tube-feet or podia in two longitudinal rows, and what may be papillæ on two peltate extensions at the posterior end. . . . The ventral sole is beautifully outlined by the marginal row of podia on each side.

Examination of the specimen (or figure) shows of course what Dr. Walcott has called the "ventral sole" and "marginal rows of podia," but neither is suggestive of any known holothurian excepting some of the bizarre Elaspod forms like *Scotoplanes*, to which Dr. Walcott refers. None of the podia are sufficiently defined to enable one to make out even the form, let alone the structure, whereas if they were really like those of *Scotoplanes* and other Elaspods, their rigidity would have caused them to be as well defined as any part of the body-outline. Dr. Walcott considers *Louisella* a genus of the Holothuriidæ, but the size and arrangement of the supposed podia are entirely unlike anything known in that family. If *Louisella* is a holothurian at all, its "ventral sole" and big podia (?) would suggest the Elaspods as its nearest allies, and the two extensions of the posterior end might be considered confirm-

atory evidence. But as there seems to be no really characteristic holothurian structure shown by the fossil, I fail to see why it should be considered a holothurian.

The small specimen of *Mackenzia* is very suggestive of a synaptid without its tentacles, but the most searching examination fails to show a single character which gives positive support to this view. The mouth and its associated structures are not distinctly indicated. As stated above, I could not distinguish any separated or definite parts in the raised ring which seems to surround the mouth, and there is nothing in it to me suggestive of the calcareous ring of a synaptid. The longitudinal markings of the body-wall are more numerous and closer together than they should be if they indicate the longitudinal muscles of a holothurian. On the whole, these longitudinal markings, the appearance of the body surface and of the oral end, and the form of the animal all seem to me suggestive of certain actinians, although I do not assert that the fossil really represents that group. The larger specimen, referred to *Mackenzia* by Dr. Walcott, shows practically no structure and in my judgment can not be assigned positively to that or any other genus.

Turning now to *Eldonia*, of which the material is plentiful and its condition such that the structure can be made out with a fair degree of completeness, we find an animal so medusoid in outer form that Dr. Walcott uses the terms "exumbrella," "subumbrella," "lobation" and "lappets" and says "the system of radial canals is very striking and medusalike." I do not recall any medusa with a canal system like *Eldonia's*, with a small central ring, but I think most of us will agree that the general appearance of the animal is that of a free-swimming Cœlenterate, except for the apparently distinct and extraordinary alimentary canal. It is upon the interpretation given this structure and upon the importance attached to it, that our final decision as to the position of *Eldonia* must depend. Dr. Walcott at first thought it might be a commensal worm but later decided it was really the alimentary canal of the animal itself, and

upon the strength of its partially spiral form, he based his decision to call *Eldonia* a holothurian. He has, however, pointed out the essential differences between *Eldonia* and *Pelagothuria*, the only known free-swimming holothurian, making it plain that they are not at all nearly allied. Emphasis should be placed on the fact that except for the expansion of the oral disk as a swimming organ, *Pelagothuria* is not an extraordinary holothurian, its internal anatomy being like that of many other members of the class. Its alimentary canal is in loops (a long drawn out spiral) and the mouth is surrounded by the usual circle of tentacles. The alimentary canal of *Eldonia* is not in loops as in a holothurian but seems to have been more nearly in a single plane like one half of the canal of a sea-urchin. The appearance of the tube thus seems to me more echinoid than holothurioid. The mouth of *Eldonia* has on either side a large tentacle; neither Dr. Walcott nor I have been able to find more than two and the whole appearance of the oral region indicates two as the normal number. The tentacles are described by Dr. Walcott as "peltato-digitate" but they have almost nothing in common with the sort of tentacles to which that term has hitherto been applied.¹ On the other hand they seem to me suggestive of the marginal clusters of tentacles in *Lucernaria* and its allies. Perhaps even the oral tentacles of some Rhizostomous Medusæ are not fundamentally different. In some of the specimens, notably the one shown in Fig. 1, Pl. 10, bits of the tentacles show some slight indications of their finer structure. In the figure referred to, small lobes or knobs above the central ring (*CR*) are noticeable and these, in the specimen, show, under the lens, a remarkable resemblance to clusters of nettle-cells. I am not sure that these lobes are part of the tentacles but if they are, as they seem to be, my opinion that the tentacles are more medusoid than like anything known among holothurians would be confirmed. *Eldonia* shows absolutely no trace of pen-

¹See Ludwig, 1892, "Die Seewalzen," p. 97; Pl. VII, Fig. 5.

tamous symmetry, no trace of calcareous structure, no longitudinal muscles and no podia. The radial canal system is utterly unlike the water-vascular system of any known Echinoderm and it is perfectly inconceivable how the fundamental, circumoral ring of a holothurian could disengage itself from the esophagus and migrate to the opposite end of the body.

If *Eldonia* is a holothurian, it becomes virtually impossible to define the class, except in terms of the alimentary canal. Indeed if *Eldonia* is a holothurian, the Echinoderms themselves can be defined in no other terms, for *Eldonia* lacks every single character which justifies the customary view that holothurians are Echinoderms. It is far less of a strain on my credulity to believe that *Eldonia*, whose extraordinary nature I have no inclination to deny, is some sort of a Cœlenterate with a commensal worm inside or under the sub-umbrella, or even that it represents a hitherto unknown phylum, than to believe that it is a holothurian or is connected, save in the remotest way, with the Echinoderms.

As a final result of my examination of the evidence, I am forced to conclude that there is no sufficient justification for the belief in a Cambrian holothurian fauna. The external form of *Louisella* and *Mackenzia* and the supposed alimentary canal of *Eldonia* can not be considered adequate basis for such a belief. There is no good evidence, either in Dr. Walcott's material or elsewhere, to show that holothurians existed before the Carboniferous. But as wheels, which are certainly of a Chiridota-like form, occur in the Zechstein of Europe, and animals closely allied to our modern Holothuria are found in the Solenhofen limestone, it is not improbable that the holothurians were differentiated about as early as the other classes of Echinoderms, excepting the Pelmatozoa. Evidence however in support of such a probability is still conspicuous by its absence.

HUBERT LYMAN CLARK

MUSEUM OF COMPARATIVE ZOOLOGY,
CAMBRIDGE, MASS.,
January 12, 1912

BIOLOGY OF MIASTOR AND OLIGARCES

THE general availability of *Miastor*, at least for laboratory work, justifies the following summary account of the biology of this interesting form and the allied, possibly sometimes associated, *Oligarces*.

Distribution.—*Miastor* is probably world-wide in distribution, having been recorded from Europe, Australia, North and South America. We have found this genus ranging in New York from the upper austral Hudson valley to the transition or boreal Adirondack region. These peculiar larvæ have also been found in Connecticut and Indiana.

Oligarces has been recorded only from Europe and North America, Albany and adjacent Nassau, N. Y., being the only American localities at present known. This species is probably widely distributed though presumably rarer or less easily detected.

Larval Habits.—The moist inner bark of various trees in the incipient stages of decay are likely places for *Miastor* larvæ. Chestnut rails, ties, stumps, the moist bark of maple, oak, birch, beech and hickory indicate no closely restricted food habits. In addition to some of the above, European report *Miastor* larvæ from elm, ash, ironwood and sugar-beet residue.

We have found *Oligarces* only in decaying elm bark, possibly because the larvæ are not so readily detected in nature.

Distinguishing Characters.—Large colonies of *Miastor* larvæ are easily recognized by the masses of more or less adherent yellowish or whitish larvæ, and especially by the occurrence here and there of motionless individuals with poorly indicated segmentation and elongate, transparent areas, the developing embryos, or containing young so well developed as to be easily distinguished with a hand magnifier, even the form of the head and the fuscous ocular spot being visible. The head of these larvæ, whether small or large, is flattened, triangular with diverging antennæ and quite different from the strongly convex, usually fuscous head of *Sciara* larvæ. *Miastor* larvæ have transverse incisural bands of

chitinous spines, best developed on the anterior body segments. These larvæ are $\frac{1}{20}$ to $\frac{1}{8}$ of an inch long and may occur in small clusters in the bark or form dense masses covering several, if not a number of square inches, frequently more or less clustered and appearing much like a mass of fungous matter commonly seen under bark.

Oligarces larvæ are similar in general aspects, though we have yet to find them in any such large masses as described above. Elm bark containing this maggot gives little evidence on the inner surface of their presence, since these larvæ appear to confine themselves mostly to the interstices of the bark.

Biology.—The larvæ of both genera reproduce by pedogenesis in the fall and early spring. We have also observed this in the case of *Miastor* in midsummer. Moisture and moderately cool weather appear to be especially favorable. With these conditions we are inclined to believe that pedogenesis may continue indefinitely, since we have kept larvæ healthy and multiplying for nearly six months with nothing more elaborate than a moist piece of decaying wood clamped lightly to an ordinary microscopic slide. A larval generation appears to occupy about 3 to $3\frac{1}{2}$ weeks, though it is evident that much depends upon moisture, food and temperature. We were fortunate in the case of two larvæ to witness the development of the egg in the ovary, its gradual separation therefrom by fission and the growth to an individual nearly ready to escape from the mother larva. This entire process occupied about three weeks. The development of the embryo is at the expense of the mother, the young absorbing their nourishment from her. Pulsations in the mother larva continue so long as a fragment of the dorsal vessel remains; in one specimen observed the dorsal vessel of the mother larva was ruptured in the vicinity of the sixth body segment and the free anterior portion continued violent pulsations and irregular wriggings till the next day, at which time the movements were much slower and by the following day had disappeared entirely.

Reproduction by pedogenesis continues in

the spring till just before the final changes to the adult, the larval colonies displaying a marked tendency to arrange themselves in groups and occasionally form rather striking combinations. This occurs, even in the case of colonies established under artificial conditions. At this season at least there is a marked tendency toward uniformity in the production of larval generations, a considerable proportion of the larva in any one colony containing embryos which may escape at about the same time and migrate to another location before establishing themselves. This removal from the exuviae of an earlier generation clearly indicates a phytophagic habit and is presumably of value in avoiding natural enemies. In early May, 1911, embryos escaped in large numbers from mother larvæ, established a colony and in a few days showed a well-developed breastbone. The transformation to the prepupa, characterized by a marked swelling and transparent condition of the anterior body segments of the larva, occurred shortly, they remained in this condition two to three days and then changed to the pupa, a stage lasting about six days. These small midges appeared in enormous numbers in our breeding jars during the late morning hours, namely, from about 9 A.M. until noon, the midges swarming over the sides of the jar and behaving much like minute ants. There is comparatively little tendency to take wing. This may continue for several days and the midges may appear in smaller numbers for a period of several weeks. Larvæ collected in the Adirondacks did not produce midges till in early August. There was a marked preponderance of one sex in rearings from a breeding jar one day, followed by an approximate reversal subsequently. This was not sufficiently marked so that we felt justified in attempting to deduce any general rule. The abdomen of the female contains four to six large eggs, each nearly as long as the abdomen. They appear to be well developed and are probably deposited shortly after the appearance of the midges and the pedogenetic generations commenced wherever conditions are favorable.

Oligarces behaves somewhat differently. A number of larvæ, probably mostly mother larvæ, containing embryos were found in elm bark March 18, 1911. This material was kept in a warm room, and a week later the interior of the jars literally swarmed with thousands of active, whitish maggots with here and there a yellowish or yellowish-transparent one. Many of these perished upon the walls of the jar, and even those confined between a piece of glass and decaying elm bark soon succumbed. In spite of this a pupa was found April 19 and adults obtained about a week later. These small, white larvæ mentioned above differed from typical *Miastor* larvæ and some, at least, evidently established themselves in the crevices of the bark, transforming to pupæ, and these in turn worked out to the free surface a day or so before the disclosure of the imago. These pupæ appeared to move more readily than those of *Miastor*, and in several instances were observed standing upon the moist surface of the bark, supported only by the somewhat mucilaginous posterior extremity.

Natural Enemies.—Both *Miastor* and *Oligarces* larvæ are subject to attack by several predaceous Dipterous larvæ occurring in similar situations. The pinkish larvæ of *Lestodiplosis*, resembling in a general way those of *Miastor* except for a difference in color and more slender structure, may be seen here and there among their prey, and in the case of populous clusters of white *Miastor* larvæ, may give an ornamental touch to the colony. *Itonida pugionis* Felt may also prey on *Miastor*. Two larger predaceous maggots, those of *Lonchæa polita* Loew and a species of *Medeterus* are commonly found in the vicinity of *Miastor* colonies, and it not infrequently happens that they are the only available evidence of the earlier occurrence of *Miastor*. The larvæ of these two latter are voracious forms and are undoubtedly responsible for the speedy destruction of many *Miastor* colonies. The finding of these predaceous larvæ may serve as a guide to the searcher for *Miastor* and suggests investigating the more inaccessible portions of the bark for colonies which may have escaped the predaceous maggots.

E. P. FELT

SPURRED FLOWERS IN CALCEOLARIA

THE genus *Calceolaria*, often popularly called slipperwort, belongs to the Scrophulariaceæ. It may be divided into two sections; first, the herbaceous kind, the one usually employed by florists in this country; second, the shrubby and bedding kinds.

The herbaceous kinds are grown from seeds. When well grown they are very ornamental and serve to decorate the greenhouse in spring, when other plants are through blooming.

The shrubby kinds are serviceable to some extent for indoor decoration. They are extensively grown in Britain for bedding purposes. Owing to the American summers being so hot, they are unsuited for bedding purposes here. They are mostly raised from cuttings.

A little more than a year ago some crossing experiments were conducted by a student in one of the regular undergraduate courses, No. 6, in the department of botany. This course was in charge of Professor Geo. F. Atkinson and Mr. Robert Shore, the head gardener of the department. The student, Miss Margaret C. Graham, performed the experiments under the supervision of Mr. Shore. Since, in public lectures, several unauthorized references have been made to these spurred calceolarias, it seems desirable to place on record the principal facts in connection with the experiments, and to state that the work is still in progress by Professor Atkinson and Mr. Shore.

A shrubby plant was crossed with a herbaceous one. This gave plants of a stronger growth, more profuse bloomers, more compact and more ornamental. Some of these varieties can be propagated from cuttings. These hybrids have been recrossed and the offspring have produced an interesting variety in habit of plants and variation of flowers. Some of the varieties have a number of spurred flowers, one or two spurs on the labelum. These spurred varieties have been cross pollinated and self pollinated, and varieties raised from these seeds have produced several spurred flowers.

GEO. F. ATKINSON
ROBT. SHORE

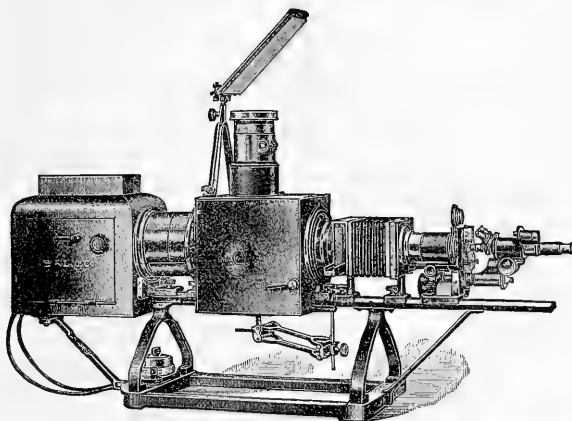
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THE PRIMARY CONCEPTS OF PHYSICS¹

THE subject of the present address is one that does not often appear on a scientific program. Physicists are so busy in enlarging the structure of knowledge that few of them concern themselves with the consideration of the fundamental concepts of the science. Yet it is plainly true that if those fundamental or primary concepts are not clearly apprehended, or if there is doubt as to what they are, the whole structure of the science rests on an insecure basis. I propose to examine certain questions concerning these primary concepts, about which there has been and is much unsettled opinion. The discussion necessarily rests upon my own beliefs about them. In the nature of the case each man can speak positively about them for himself only. It would be very improper to dogmatize, and I shall accordingly have to crave your pardon for a frequent expression of my own opinion, believing it less objectionable to be egotistic than to be dogmatic.

The first question which I shall consider is that raised by the advocates of the dynamical definition of force, as to the order in which the concepts of force and mass come in thought when one is constructing the science of mechanics, or in other words, whether force or mass is the primary concept. It will be of service in the discussion if we consider briefly the way in which some of the great builders of the science of mechanics used these concepts.

¹ Presidential address delivered before the American Physical Society and Section B of the American Association for the Advancement of Science, at Washington, D. C., December 28, 1911.

There is no need of presenting the views of Archimedes or of Stevinus, whose work was exclusively in statics and who used the concept of force given us by our muscular or motor sense, and measured forces by weights. The views of Galileo, however, are interesting as showing how far one can go in dynamics without using the concept of mass.

Galileo examined the problem of the motion of a body acted on by a constant force. The only constant force of which he could dispose was the weight of a body, or a component of its weight, and he accordingly was limited in his studies to the examination of the laws of falling bodies. Owing to the relation of proportionality between the weight of a body and its mass, this limitation in a way simplified the problem, while at the same time it made it more difficult to develop a complete doctrine of force and motion. By the famous experiment at the Leaning Tower Galileo satisfied himself that he could study any falling body as a type, and that the conclusions which he would reach from that study would apply to all. His attention was therefore directed almost wholly to the consideration of the motion of the falling body, while the question of the relation between the motion and the weight of the body was disregarded. The result of this was that he developed the laws of linear motion with constant acceleration, and numerous consequences of those laws, chiefly relating to motion down inclined planes, with really wonderful completeness, and was led in the course of his thought to a full appreciation and statement of the principle of inertia, while yet he did not, in this part of his work, attain to any useful conception of the relation of force to mass. He makes it clear that the conception of force which is sufficient for his purposes is that with which he was

familiar from his study of statics. He says, in speaking about the "tendency" of a body to fall down inclined planes of the same height, that "It is clear that the tendency of a body to fall is as great as the resistance or the least force which suffices to prevent its falling and to keep the body at rest." In fact Galileo thought of the weight of a body, with which he was familiar from common experience, as a force which moved the body, and assuming that the weight was unchanged during motion his experiments demonstrated what kind of motion such a constant force will set up and maintain.

In the very interesting discussion which Galileo gives of the forces exerted by the collision of one body against another, he approaches nearer than in other parts of his discourse to an appreciation of mass as a characteristic of a moving body. He speaks in one place of the falling body being a composite of weight and velocity, and his discussion of the impulse applied by such a falling body to another on which it falls shows that he was very near the concept of momentum; but there is no real precision in his statements.

We now turn to Newton to get the full doctrine of the relations of force and motion. It will be clear to any one who examines the introductory parts of the "Principia," that Newton did not undertake in that book to present a systematic treatise on dynamics. He merely blocks out a rough set of definitions and postulates, in a very uncritical way, which are sufficient to enable him to go on as promptly as possible to the real task which was before him. A striking instance of this uncritical attitude of mind is found in Definition I., in which he says, "Quantity of matter is its measure derived from its density and volume jointly." This quantity of matter thus defined he names

mass. Since we can only define density in terms of the concept of mass, it is surely uncritical to define mass in terms of density. In fact Newton on a later page uses the true definition when he says that bodies are of the same density if their *vires inertiae* (that is, their masses) are proportional to their volumes.

The same sort of uncritical treatment appears in his presentation of the various types of force. He mentions first the *vis insita*, which he defines as the power of resisting, by which a body persists in its state of rest or of uniform motion. He says it differs in no respect, except in the way of conceiving of it, from the inertia of a mass.

Then comes *vis impressa*, the action (*actio*) exerted on a body to change its state of rest or of uniform motion. This is force in our ordinary sense. Newton says that it arises from a blow, from pressures or from centripetal force.

Vis centripeta is the force by which bodies are drawn or impelled from all directions toward any point as a center, or tend toward it in any way whatever. The force of gravitation and magnetic force are examples of this centripetal force. So also is the force by which a sling draws a stone in it toward the hand, which force Newton explains as arising from the stretching of the cord of the sling.

Newton then goes on to define the various measures or modes of giving quantitative expressions for centripetal forces. He first describes the *vis centripetæ quantitas absoluta* as the measure of it as greater or less by comparison with the efficiency of the cause which transmits it from the center through the surrounding region. Thus the magnetic force is greater in one magnet than in another, either because of the greater mass of the one or of the intensity of its power.

The *vis centripetæ quantitas acceleratrix* is the measure of it as proportional to the velocity which it generates in a given time. Thus the power (*virtus*) of a magnet is greater at lesser distances, and less at greater distances; gravitating force is greater in valleys, less on mountain peaks, and less still at greater distances from the earth. At equal distances, he says, this gravitating *vis acceleratrix* is the same everywhere, because all falling bodies are equally accelerated.

The *vis centripetæ quantitas motrix* is the measure of it as proportional to the momentum which it generates in a given time. This quantity is the center-seeking or tendency to the center of the whole body, and (as Newton says, with an evident appreciation that he is limiting the generality of his conception) is the weight of the body. It is always known by the force opposite to it, and equal to it, by which the fall of the body can be prevented.

Newton calls these quantities of force of the various sorts described by the shorter terms motive, accelerative and absolute forces, that is, he substitutes the general terms for the measured quantities of the forces which can be conceived only in those general terms. With this understanding he states that the *vis acceleratrix* is to the *vis motrix* as velocity is to momentum; for the quantity of motion (*momentum*) arises from the velocity and quantity of matter, and the *vis motrix* arises from the *vis acceleratrix* and the quantity of matter. For the sum of the actions of the *vis acceleratrix* upon the several particles of a body is the *vis motrix* of the whole body. Newton relates the *vis motrix* to a body as a striving of the whole body towards the center, made up of the striving of all its parts; the *vis acceleratrix* to the position of the body, as a certain efficiency, diffused from

the center through all places around it, for moving bodies which are in those places. The *vis acceleratrix* as thus described reminds us of the conception of the strength of a field of force.

This analysis of the concept of force surely does not promote a clear apprehension of it. The only one of the distinctions which have been made which seems to be worth retaining is that between the *vis impressa*, or action, and the *vis motrix impressa*, the one being force in its general or conceptual sense, the other the same force when given a measure or value. This distinction was clearly in Newton's mind and appears in the enunciation of the Laws of Motion. In the First Law the departure of a body from its state of rest or of uniform motion is ascribed to the *vis impressa*; that is, to force in general, without any specification as to its measure or even any declaration that it can be measured. In the Second Law the change of momentum is said to be proportional to the *vis motrix impressa*; that is, to force that is measured so that a proportionality to something else can be predicated of it. As has already been stated, Newton declared of this *vis motrix* in the special case of gravitation that it is known, or measured, by the force opposite to it and equal to it, by which the fall of the body, or, in the general case, the motion of the body, can be prevented. In the Third Law the force is called *actio*. This is the alternative word used in the definition of the *vis impressa*, as an equivalent for force in its general sense. The word in this sense is consistently used in the enunciation of the Third Law, in which forces are not considered as measured, but merely as compared by the condition of equality. From the examples of action and reaction which Newton gives (the finger pressed against a stone; the horse drawing a stone by a rope and drawn

back equally toward the stone, because of the stretching of the rope and its exertion of equal forces at its two ends) it is plain that Newton conceived of forces in the way which is familiar to all of us, as the pushes and pulls which can be perceived by our motor sense, and as the causes of motions. He goes on to say that by these *actions* there are caused equal changes, not of velocity, but of momentum, so that the changes of velocity are inversely as the bodies (*corporibus*). In this way, without measuring forces, there is introduced the method of comparing masses.

It is difficult to perceive in these many definitions and declarations exactly what Newton's conception was of force, of the unit in which it is measured and of its relation to mass. After careful consideration of all that I can find in the "Principia" bearing on the question I am convinced that Newton viewed the concept of force as a primary one, or one directly given by intuition, and that he thought of the motions of bodies caused by these forces as connected quantitatively with them by the experimental relation embodied in the Second Law. Since Newton does not use a system of units, and states most of his laws and theorems in terms of proportions, the priority of force to mass, in the order of their apprehension, is not clearly presented.

In the matter of measuring a force he clearly asserts that a *vis motrix* is measured by the force which will counteract it and keep the body to which it is applied at rest, and the force thus used can hardly be other than a force measured statically; but his frequent insistence on the measure of *vis motrix* by the momentum which it causes shows that he had a conception also of the dynamical measure of force. He further supplies the measurement of mass as a fundamental quantity which is needed

to establish the dynamical measure of force by calling attention to the possibility of comparing masses by means of the velocities given them when acted upon by equal forces.

Lagrange in the "Mécanique Analytique" gives the most explicit expression to the definition of force in general which is the bugbear of so many thinkers, and which yet, after all, is the real expression of our belief about force, when he says:

We understand by force the cause, whatever it may be, which impresses or tends to impress a motion on a body to which we suppose it applied.

He goes on to say:

It should be measured by the quantity of motion impressed or ready to be impressed. In the condition of equilibrium, the force produces no actual effect; it produces only a simple tendency to motion; but it should be measured by the effect which it would produce if it were not restrained from acting.

Lagrange repeats this definition of the measure of force in the introduction to his "Dynamics," when he says that the product of the mass and the accelerating force (Newton's *vis acceleratrix*) or the acceleration, expresses the motive force (Newton's *vis motrix*). I can not find that Lagrange gives any definition of mass. From a statement in his treatment of centers of gravity it would seem that he considered the mass to be determined by its weight. He seems to endeavor to measure force in the purely dynamical way, without going into the matter as fully as he should for a complete elucidation of it.

Thomson and Tait say flatly that force is a direct object of sense, and define it as any cause which tends to alter a body's natural state of rest, or of uniform motion in a straight line. They assert that the measure of force is the quantity of motion which it produces per unit of time. They give no other definition of mass than the one given by Newton.

From the account which has been given of the views held or expressed by some of the great leaders of thought in matters of dynamics it is clear that very indefinite notions existed in their minds with respect not only to the proper definition of force, but even with respect to the proper measure of force, which is fundamental and necessary in the development of dynamics. The acute and valuable criticism by Mach of this fundamental notion is so colored in its expression by Mach's favorite principle of economy that it is not altogether satisfactory, and I accordingly shall attempt to present what seems to me the proper order of thought on this matter. Similar statements have been many times made, but there is still no general consent in the minds of physicists as to the statement which should be acceptable to every one.

There is no doubt that the dynamical *measure* of force is the correct one to use in building up a system of units. The point of difference on which dispute arises is the order of precedence of the two concepts force and mass in the establishment of this definition. It is not uncommon to have force defined as the product of mass by acceleration, or of mass by the acceleration which the mass would have if it were free to move. In this definition mass is the primary concept. Now, as I view the question, force is the primary concept, a direct object of sense, and we know it to be a cause of motion, or of the distortion of a body to which it is applied and which counteracts it when the distortion has reached a certain limit. In particular we know it as counteracting, or as being counteracted by, the weight of a body. This conception of force is adequate for the development of statics, in which we treat the principles of statics as statements of laws which are derived from experiment and confirmed by the proof that they are

mutually consistent. Galileo's experiments on falling bodies are then the direct experimental proof in a limited case of the proportionality between the force which acts on a body, measured at any one place by a weight, and the acceleration imparted to the body. Newton's Second Law is a statement of Galileo's discovery, with this addition, that the acceleration imparted by a force is not the same for all bodies, but depends upon a certain characteristic of the body. This characteristic, the mass of the body, first calls for recognition at this point. In the view I have taken the mass is the factor of proportion between the force which acts on a body and the acceleration which it imparts to the body. Since we can measure forces by comparison with a standard force, we can also measure masses by the aid of properly instituted experiments. Whether we measure masses in this way or not, and it turns out to be not a satisfactory way to do it, we at least get from this relation between force, of which we have a concept, and motion, of which we have a concept, an adequate working concept of mass. Force is the primary concept and mass is a derived concept.

Now owing to the permanency of masses of matter it is convenient to construct our system of units with a mass as one of the fundamental units. We are able to do this and to compare one mass with another chosen as standard, without going through the operation of measuring forces, by utilizing the principle embodied in Newton's Third Law. This law asserts that bodies which interact, that is, which exert forces on each other, exert equal forces, and thus, if the bodies are free to move, their acceleration will be inversely as their masses. By observation of the accelerations of two mutually interacting bodies we may thus compare their masses, and so

construct a set or scale of masses, and use these masses and their accelerations to measure forces. Thus while the concept of force is primary in the order of thought, we may make the unit of mass fundamental in the development of a system of units.

The point upon which I wish to insist is that both reason and the history of mechanics show that the foundation of the science is the purely intuitional concept of force which is shared by every intelligent being, and that this intuitional concept is not only accurate so far as it goes, but adequate to serve as the foundation of a great science. No use of the concept of force in the theories of physics has ever violated in any particular this original and intuitional concept of it. Even the brilliant endeavor of Hertz to found all the principles of dynamics upon the three concepts of time, space and mass can not escape the criticism that the concept of mass is meaningless to us unless it is given to us by our experience of the inertia of matter when we exert force upon it. Once that concept is attained it may be used, as Hertz so beautifully used it, in the logical upbuilding of a system of dynamics. Perhaps my contention will be made clearer if we consider briefly the question whether it would be possible for us to construct our present system of dynamics if we were disembodied spirits, gifted with the means of observing spaces, times and colors, but without the sensation of force. We could see colored volumes, sometimes moving with constant velocity, sometimes with varying velocity, and we could ascribe the changing velocity to the action of a force. We further could connect the force with the moving volume by setting it equal to the acceleration multiplied by some factor which we might name the mass. This equation would contain two unknown and

unmeasured quantities, and would mean nothing unless we could go further. Now the advocates of the purely dynamical definition of the concept of force say that we can go further, by observing the mutual accelerations of two bodies and using these to obtain the ratio of their masses. If this can be done the matter is settled. But could it be done by the disembodied spirit? In our use of the mutual accelerations of two bodies to get their masses we must explicitly state that the bodies are arranged so as to interact (that is, to exert force on each other), and unless that condition is established the mutual accelerations of two bodies, however often repeated, can tell us nothing about their masses. A man at a station might observe two trains leaving the station in opposite directions with the same accelerations every day for ten years, and yet he could not compare their masses by any such observations. Eyes and mind only will not do it. To get the measure of mass we must start with the intuitional knowledge of force, and use it in the experiments by which we first define and then measure mass.

I now come to a much more difficult part of my subject, the consideration of the other primary concepts of space and time. Not many years ago we should have been willing to pass them over with a mere mention, admitting the impossibility of giving a definition or even an intelligible description of either of them, admitting the impossibility of determining an absolute or fixed point in space, or an absolute instant of time, but still asserting that we knew something about them both of which we were sure. At present we are driven by the development of the principle of relativity to examine anew the foundations of our thought in respect to these two primary concepts.

I suppose that the old ideas about space and time that have been of service to physicists since the beginning of the science are summed up as well as anywhere in Newton's words:

Absolute and real time, the time of the mathematician, flows on equally, having no relation in itself or its nature to any external object. It is also called duration. Relative, apparent time, the time of common life, is an external measure of any duration cognized by the senses, by means of motion. It is commonly used in place of real time.

Absolute space, having no relation in its nature to any external object, always remains alike everywhere and immovable. Relative space is the measure of this space, or any movable dimension, recognized by our senses as limited by its situation with respect to bodies. This is commonly thought of as equivalent to absolute space.

These definitions have been often justly criticized for the emphasis laid on the unfruitful ideas of absolute time and space. Perhaps the criticism has fallen rather upon Newton's subsequent expansion of his thought on these ideas. But do they not contain in the first place the conceptions of time and space which have been uniquely useful up to this time in physics, and in the second place, do they not contain what each one of us really thinks about time and space when he makes an honest examination of his knowledge? The essential feature of both these descriptions for our present purpose is Newton's declaration, both as to time and space, considered as species and not as magnitudes, that they are in themselves and in their nature without relation to any external object. It is this statement which is contradicted by some of the enunciations of the principle of relativity.

It is not necessary for me to give an account of the genesis of the principle of relativity. It may fairly be said to be based on the necessity of explaining the negative result of the famous experiment of Michelson and Morley, and on the con-

venience of being able to apply Maxwell's equations of the electromagnetic field without change of form to a system referred to moving axes. It is not needed to explain many of the remarkable results obtained by Fizeau, by Mascart and by Brace, in the field of experimental optics, which to a first inspection seem to show that the earth and the medium around it through which light passes are relatively at rest, but which a closer study by Lorentz and others shows may be compatible with a reasonable theory of the structure of matter and the hypothesis that the luminiferous medium is at rest. It is also not needed to explain the dependence of the path of an electron in a field of crossed electric and magnetic forces upon its velocity, as exhibited in the beautiful experiments of Kauffmann and of Bucherer, for other theories in which the principle is not used lead to expressions for the path which, for the present at least, are in as good accord with observation as those which are deduced by the aid of the principle of relativity.

There are two ways of presenting the principle of relativity. In the first way the principle is stated as a direct inductive conclusion from the experiment of Michelson and Morley, and asserts that so far as a conclusion can be drawn from that experiment and the others which have been tried to test the matter, there is no way by which the relative motion of the earth and the luminiferous medium can be determined from observations made on the passage of light when the source of light and the observer are moving with the earth. As thus presented the principle holds out as the object of future study the construction of a suitable theory of the structure of matter and of the luminiferous medium to account for this fundamental experiment as well as for all other known truths in the domains of light and electricity. If

this theory is expressed in terms of the Lorentz transformation, and thus shows a dependence of the measure of time and the measure of length upon the velocity of the system in which the observer is placed, it will further be the object of inquiry to construct a theory of the relations between the material of the system and the luminiferous medium which will account for the change in the units of length and in the motions of bodies by which the unit of time is determined. When I say to account for, I mean to describe in terms of force, time and space, as we conceive those notions in our every-day experience, and as we use them in our ordinary physical work, so that the description when apprehended will be reduced to the lowest terms in which our thought about the universe can be expressed. Such a description is, as I view it, a real explanation, and surely it is not yet time to say that such an explanation is impossible.

The other way of presenting the principle of relativity consists in laying down as a fundamental postulate a general proposition expressing the hopelessness of any attempt to settle the question raised by the experiment of Michelson and Morley by any theory of the structure of the universe. This postulate sometimes assumes a formidable aspect, and involves more than the mere postulate of relativity. Thus Laue says:

The principle of relativity asserts that from the totality of natural phenomena we may, with continually increasing approximation, determine a system of reference, x, y, z, t , in which the laws of nature hold in a definite and mathematically simple form. This system of reference is by no means uniquely determined by the phenomena. There is rather a triple infinity of equally admissible systems, which move relatively to one another with uniform velocities.

The feature of this enunciation of the principle to which I referred as an addi-

tion to the principle is the expressed condition that in the system of reference the laws of nature hold in a definite and mathematically simple form. There is no warrant in the past history of physics for the adoption of such a postulate as that. Surely the history of the discovery of the so-called secondary laws of physics, such as Boyle's law, the laws of friction, the laws of polarization and of absorption of light, the laws of magnetization, and many others, will bear out the statement that in very many cases the first enunciation of the law is in a definite and mathematically simple form, and that further knowledge shows that this form is only a first approximation to the truth. Even in the case of such laws as the law of gravitation, or of electrical attraction and repulsion from which we have not yet detected any deviation, does any one dare to say that they are universally true for all bodies and at all distances? Can we even feel sure that Maxwell's electromagnetic equations hold true with absolute exactness? They need supplementing when they are applied to material bodies. Can we be sure that they hold without modification, in rapidly moving bodies, or at extremely minute distances in free space. Or, from another point of view, admitting that the object of physical study is to reduce the description of natural phenomena to a set of simple laws, have we a right to assume that, in our analysis of the structure of matter and of the luminiferous medium, we have as yet reached the ultimate model in which such simple laws will be operative? The answer to this question must be a negative one. Yet it is surely true that if it were not for this demand of simplicity, immediately attainable and at present expressed in the electromagnetic equations, the chief incentive to the development of the theory of relativity would be wanting.

But this is not the heart of the matter. With the principle of relativity as a basal postulate, not expressing our present inability, but rather the hopelessness of any attempt to obtain ability, a complete description has been given of the phenomena now known to physicists, at least in the domains of mechanics, light and electricity. The difficulty which I find in accepting the principle, with the universality that is predicated of it, is that it does so much more than this.

The theories of J. J. Thomson and of Lorentz made physicists familiar with the notion of electrical mass, exhibited by the variability of the mass of a moving charged body, or by the apparent variable inertia of a moving charge expressed as a function of its velocity, and further with the notion that as the velocity of the charge approaches the velocity of light the magnitude of the electrical mass approaches infinity, so that the velocity of an electrical charge, of an electron, and therefore presumably of matter, if it is entirely electrical in its structure, can never surpass the velocity of light. In these theories this remarkable conclusion was explained by the interaction between the moving charge and the ether. In the theory of relativity the same conclusion is reached as the consequence of a purely kinematical theorem, giving the rule for the addition of velocities, and not only does it hold for real moving charges, but for any action whatever which is conceivably transmitted through space. In particular this finite velocity of transmission must be ascribed to gravitational action. Now the Newtonian theory of gravitation assumes a practically infinite velocity of transmission of gravitational action, and astronomical observations have never given any warrant for the belief that its velocity of transmission is even of the order of mag-

nitude of the velocity of light. The attempt has been made to reconcile the theory of relativity with the observed motions of the planets by the adoption of an arbitrarily chosen term in the formula for the force on a planet to represent what is equivalent to a counteracting force to annul the tangential acceleration which would arise from the finite rate of transmission of gravitational force. This is manifestly an artifice and not an explanation. If the principle of relativity is of universal application, it should not need the introduction of such an artifice to help it out in the solution of one of the classical problems of physics.

Further, the principle of relativity in this metaphysical form professes to be able to abandon the hypothesis of an ether. All the necessary descriptions of the crucial experiments in optics and electricity by which the theories of the universe are now being tested can be given without the use of that hypothesis. Indeed the principle asserts our inability even to determine any one frame of reference that can be distinguished from another, or, what means the same thing, to detect any relative motion of the earth and the ether, and so to ascribe to the ether any sort of motion; from which it is concluded that the philosophical course is to abandon the concept of the ether altogether. This question will be amply and ably discussed this morning, but I may venture to say that in my opinion the abandonment of the hypothesis of an ether at the present time is a great and serious retrograde step in the development of speculative physics. The principle of relativity accounts for the negative result of the experiment of Michelson and Morley, but without an ether how do we account for the interference phenomena which made that experiment possible? There are only two ways yet thought of to account

for the passage of light through space. Are the supporters of the theory of relativity going to return to the corpuscles of Newton? Are they willing to explain the colors of thin plates by invoking "the fits of easy reflection and of easy transmission?" Are they satisfied to say about diffraction that the corpuscles near an obstacle "move backwards and forwards with a motion like that of an eel"? How are they going to explain the plain facts of optics? Presumably they are postponing this necessary business until the consequences of the principle of relativity have been worked out. Perhaps there is some other conceivable mode of connection between bodies, by means of which periodic disturbances can be transmitted. We may imagine a sort of tentacular ether stretching like strings from electron to electron, serving as physical lines of force, and transmitting waves as a vibrating string does. Such a luminiferous medium would not meet the postulate of simplicity, but it conceivably might work. But whatever the properties of the medium may be, there is choice only between corpuscles and a medium, and I submit that it is incumbent upon the advocates of the new views to propose and develop an explanation of the transmission of light and of the phenomena which have been interpreted for so long as demonstrating its periodicity. Otherwise they are asking us to abandon what has furnished a sound basis for the interpretation of phenomena and for constructive work in order to preserve the universality of a metaphysical postulate.

The electromagnetic equations, too, the retention of which in their present simple form is the *sine qua non* of the promoters of the principle of relativity; were not only developed by the conscious use of the hypothesis of a medium in which the electric and magnetic forces exist, but can be inter-

preted intelligibly only in terms of some such medium. The abandonment of this hypothesis reminds one of Baron Münchhausen's feat performed while he was making his escape from prison. Since your historical reading may not have extended to the autobiography of this famous man, I may be permitted to relate that the Baron was letting himself down from the windows of a high tower by a rope, and when he reached the end of it he found that he still had a long distance to go. The last part of the descent was particularly difficult, so to get rope enough he ingeniously spliced on an additional piece, which he obtained by cutting off the part above him.

The principle of relativity in its metaphysical form ignores the accelerations of bodies. It is true that the experimental results to which the principle has been applied with such success are such that the study of acceleration in terms of the theory of relativity has not become necessary. But is it not reasonable to suppose that when suitable experiments have been invented and tried to test the effect of the acceleration of a system on the progress of light in it, it may be found that an effect can be detected? — Some effect may be detected, for example, due to the rotation of a body. I have never been able to perceive any sound objection to Newton's assertion that we have evidence of absolute rotation by the observation of centrifugal force, and if a fixed direction of an axis and an absolute velocity of rotation can be determined in a mechanical system when accelerations are taken into consideration, why should the principle of relativity be treated as having universal validity?

But, after all, these questions raised by the development of the principle of relativity are of secondary importance. The central question is whether or not this prin-

ciple can ever furnish a satisfactory explanation of natural phenomena. The formulas derived from it are evidently merely descriptive. This may be said with truth about all the formulas in which the general theories of physics have been embodied. Kirchhoff designates, as the task of the science of mechanics, the description of the motions which occur in nature completely and in the simplest possible way. This assertion that the task of the theoretical physicist is done when he has reduced the phenomena with which he is dealing to a set of formulas, or, as we may say, when he has constructed an ideal model which will reproduce the phenomena, is one to which we would all assent in general. At the same time most of us would reserve the right to criticize each model thus presented, and to give to one or the other a preference based on considerations which are not necessarily limited to the simplicity of the model or to the completeness with which it reproduces the phenomena. Surely an additional test of the value of the model will be the intelligibility of the elements of which it is composed.

This last test has been generally met in the models which have been proposed as descriptions of natural phenomena. We can understand from what we see and feel what is meant by the motions of elastic spheres, and the model which uses them to represent the behavior of a gas is not only competent to reproduce the behavior of a gas, but is intelligible in the elements of which it is composed. The model of the elastic solid ether, incomplete and objectionable as it became when the subject of optics was enlarged and developed, was intelligible in its elements. The model of electromagnetic operations embodied in Maxwell's formulas is also one which is thus intelligible in its elements. When I say this I do not mean that we know all

about electric and magnetic forces, but I mean that we do know enough about such forces to have a clear notion of their variation in space and their variation in time.

This feature of the ideal model or description seems to me to be necessary in order to make the model acceptable as the ultimate or last attainable explanation of phenomena. The elements of which the model is constructed must be of types which are immediately perceived by the senses and which are accepted by everybody as the ultimate data of consciousness. It is only out of such elements that an explanation, in distinction from a mere barren set of formulas, can be constructed. A description of phenomena in terms of four dimensions in space would be unsatisfactory to me as an explanation, because by no stretch of my imagination can I make myself believe in the reality of a fourth dimension. The description of phenomena in terms of a time which is a function of the velocity of the body on which I reside will be, I fear, equally unsatisfactory to me, because, try I ever so hard, I can not make myself realize that such a time is conceivable.

Tried by this test, I feel that the principle of relativity does not speak the final word in the discussion about the structure of the universe. The formulas which flow from it may be in complete accord with all discovered truth, but they are expressed in terms which themselves are not in harmony with my ultimate notions about space and time. That this is true is so evident that it is generally admitted. Some writers say that we should not let this circumstance disturb us, because Kant has said that time and space are mere forms of perception, a scheme in which we must arrange occurrences so that they may acquire objective significance. I do not altogether understand what Kant meant by this, but I am

sure he did not mean that by the exercise of our wills we can violently eject from our consciousness the notions of space and time which we have in common with the whole race of man, and impose on ourselves other and radically different notions. Planck compares our position before the new notions presented by the theory of relativity to the position of the medieval peoples before the notion of the antipodes. It seems to me that there is no real similarity between the two positions. Many men in the Middle Ages believed that there were no antipodes, but their belief was based on reasons, and so far were they from being unable to conceive of antipodes and to believe in their existence, that there were men who actually maintained their existence, and were pursued therefor as heretics. I do not believe that there is any man now living who can assert with truth that he can conceive a time which is a function of velocity or is willing to go to the stake for the conviction that his "now" is another man's "future" or still another man's "past."

One of the members of this society, recognizing our present inability to conceive of relative time, and conceiving our intuitions of space and time to be the result of heredity operating through many generations of men who lacked the light of relativity, once proposed to me that every one who could get even a glimmer of the notion of relative time should persistently exercise his mind therein and teach it to his students, in the hope that in a few generations the notion would emerge with the force of an intuition. It would not be fair to leave the impression that he was solemnly serious when he made this suggestion. When Matthew Arnold was asked to endure the transliteration of Greek names into English in order that the new forms might become familiar to future scholars,

he answered that he was not willing to spend his days in a wilderness of pedantry that his children might enjoy an orthographical Canaan; and *mutatis mutandis* the same answer may be given in this case. But a more pertinent answer is, to my mind, this, that the attempt to reorganize the perceptions of the human mind in respect to space and time is doomed to failure. "Which of you by taking thought can add one cubit unto his stature?" I believe that these ultimate perceptions are the same for all men now, have been the same for all men in the past, and will be the same for all men in the future. I believe, further, that this is true because the universe has a real existence apart from our perceptions of it, and that through its relations to our minds it imposes upon us certain common elementary notions which are true and shared by everybody.

Therefore, from my point of view, I can not see in the principle of relativity the ultimate solution of the problem of the universe. A solution to be really serviceable must be intelligible to everybody, to the common man as well as to the trained scholar. All previous physical theories have been thus intelligible. Can we venture to believe that the new space and time introduced by the principle of relativity are either thus intelligible now or will become so hereafter? A theory becomes intelligible when it is expressed in terms of the primary concepts of force, space and time, as they are understood by the whole race of man. When a physical law is expressed in terms of those concepts we feel that we have a reason for it, we rest intellectually satisfied on the ultimate basis of immediate knowledge. Have we not a right to ask of those leaders of thought to whom we owe the development of the theory of relativity, that they recognize the limited and partial applicability of that

theory and its inability to describe the universe in intelligible terms, and to exhort them to pursue their brilliant course until they succeed in explaining the principle of relativity by reducing it to a mode of action expressed in terms of the primary concepts of physics?

WILLIAM FRANCIS MAGIE

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THE MOVEMENT FOR SCIENTIFIC INTERNATIONALISM AT THE HAGUE

PEDAGOGY lays ever greater emphasis on positive suggestion of the things that are good to do, rather than on negative prohibition of what is undesirable. The peace movement, as one of the biggest educational problems now in hand, is applying this principle in many ways. Everything which makes more evident the common interests of mankind tends toward peace as it awakens the larger loyalties which more and more take the place of primitive Chauvinism. The things which are specifically national are few and the things which are co-extensive with human thought and human effort, many. If a realization of this fact were deep enough and wide enough men would altogether refuse to allow their interest and their public moneys to be diverted from the great common task, the advance of knowledge and its application to human welfare, by the little jealousies between groups which happen to live under different political organizations. The Foundation for the Promotion of Internationalism at The Hague has for its purpose the furthering of those movements for intellectual and social progress which are international in scope, and by so doing it plays an important part in the growth of the spirit of world peace.

It is obvious that, if such ends are to be realized, the efforts made must tend to meet practical needs in various fields of thought and action and not merely express a vague aspiration toward abstract ends. The Foundation for the Promotion of Internationalism has therefore addressed itself to a systematic study of the various movements for inter-

nationalism and the needs which they indicate, the shortcomings of previous efforts and the most profitable lines for future advancement. Two monographs already prepared by Dr. P. H. Eijkman, Director of the Preliminary Office of the Foundation, deal with "*L'Internationalisme Medical*," 1910, and "*L'Internationalisme Scientifique*," 1911, and these volumes furnish a most impressive argument for the "organization of organizations" contemplated by the foundation.

The advantages to be gained by international organization may be best estimated perhaps by considering what national associations have already accomplished within their more limited territory. The services of the American Association for the Advancement of Science, the American Medical Association and the American Public Health Association and the American Chemical Society, for example, have been notable forces in their respective fields. Such organizations serve a twofold purpose. On the one hand, by their meetings and by their publications they serve as a medium of communication between their members, bringing the experience of each to the service of all. On the other hand, they serve as an authoritative medium of communication with the public, furthering as occasion demands a popular knowledge of the subjects with which they deal, and presenting a united influence upon official action to which their sciences are, or should be, related.

The transition from such national societies to international ones has been a natural and inevitable one, and has led to the formation of world organizations and world congresses, in profusion. How numerous such international efforts have been no one probably realized until Dr. Eijkman brought them together (for medicine and for pure science and letters) in the two volumes to which reference has been made. In the second of his books he lists over 600 international organizations and Professor Baskerville in an article on International Congresses in *SCIENCE* for November 11, 1910, catalogues 125 international congresses in science alone. These diverse international societies and congresses have proved of great

importance; but they fall far short of the needs, for a world organization of intellectual effort. For the most part there has been no permanent organization to connect adequately the work of successive congresses and there has nowhere been a due correlation between the work of different groups, drawn together often by some local or temporary need. There is duplication, on the one hand, with unoccupied fields on the other, and while certain congresses have been markedly successful, others have fallen short of reasonable expectation. All these defects must be to some extent inherent in human undertakings; but they could surely be minimized by a central bureau which could correlate the more important lines of intellectual activity and give to each of them a permanent organization.

Such an idea led to the establishment of the Office Centrale des Institutions internationales at Brussels and to the calling together under its auspices, of the *Congres mondial des Associations internationales* in 1910. The field covered by this congress was so wide, however, that it could hardly hope to accomplish very much along specific lines. Every sort of international movement was included in the Brussels program and it is a somewhat large task to organize all at once the whole field of international life. The Foundation for the Promotion of Internationalism at the Hague has wisely determined to address itself rather to the specific problems presented by certain definite branches of science rather than to any all-embracing programs.

The most promising line of advance, as Dr. Eijkman has well shown in his volume on "*L'internationalisme scientifique*," has been marked out by the development of permanent organizations, of international scope, but dealing with related problems and representing naturally cooperative groups. Of these the *Association internationale des Academies* furnishes the most notable example. Representing as it does twenty-two academies in the leading scientific nations of the world, it occupies an authoritative position in pure science and letters and it has undertaken since its first general meeting in 1901 a series of

practical tasks of the first magnitude, tasks which only a world organization could successfully undertake. Among them may be mentioned the publication of a complete edition of the works of Leibnitz, an encyclopedia of Islam, a critical edition of the Mahabharata, an annual publication of physical and chemical constants, the measurement of an arc of the thirtieth meridian, the organization of a central committee for the study of the brain and the development of the work of the Institut Marey and the laboratories on Mont Rose.

The International Association of Academies still lacks, however, a permanent home and an opportunity for correlating its efforts with those of similar organizations dealing with related work in various branches of applied science and art. This is the dream of the Foundation for the Promotion of Internationalism, a series of such strong international bodies representing the most important fields of intellectual endeavor, all with permanent bureaus at the Hague, and all working together on definitely correlated lines for the organization of human effort.

This is not merely a dream. Two such bureaus are already well under way and a third has just come into existence. The Bureau de la Commission permanente des Congres internationaux de Medecine was established at the 16th International Congress of Medicine at Budapest in 1909. Its functions include the general planning of congresses and the arbitration of disputed points, the designation of place of meeting, standards for membership, official languages, number and scope of sections and number of papers presented, scrutiny of the votes passed by sections, correspondence with other international congresses and societies in order to avoid conflict, the promotion of the study of medical questions requiring international cooperation and the institution of commissions for such purposes. At the Brussels meeting of the International Congress of Pharmacy in 1910, a similar organization was effected in the shape of a Bureau permanent de la Federation internationale de Pharmacie, also with offices at

the Hague. The objects of this international federation are fully and definitely outlined and include the collection and dissemination of data in regard to scientific and practical pharmacy, the promotion of uniformity in educational requirements for pharmacists, the study and dissemination of information in regard to laws relating to pharmacy, the organization of international pharmaceutical congresses, collaboration with other international societies and many more. The third permanent international bureau at the Hague has just been established in the form of a Bureau permanent de l'Institut international de Statistique.

The Foundation for the Promotion of Internationalism, which was an active agent in the creation of these three bureaus, is anxious to continue its admirable work by the development of similar permanent organizations in related fields. Dr. Eijkman, its director, is at present in America with a view to arousing interest in three such undertakings which seem of immediate practical importance. The first of these is a permanent international bureau for pure science and letters which would seem to be a natural development of the International Association of Academies and might properly be undertaken under its auspices. The second is a similar bureau for hygiene (public health would be a far better term, but the word hygiene is probably too firmly entrenched in European parlance to be dislodged). Public health has far outgrown the bounds of medicine, since it includes specialists in engineering, biology, bacteriology, chemistry and statistics, as well as in medical science; and the Permanent Commission of International Medical Congresses at its first meeting in London endorsed the plan for a bureau of hygiene at the Hague. No field of scientific effort has more manifold international relations than public health and it is to be hoped that the International Congress of Hygiene and Demography may take definite steps toward this end at its meeting in Washington next fall. Finally, the Foundation for Internationalism hopes to secure the establishment of a third new bureau

dealing with technology; and the International Congress of Applied Chemistry which meets in Washington and New York in September might well institute a movement toward this end.

These plans for international scientific bureaus at the Hague have the cordial support of the government of the Netherlands which is financing the bureaus so far created and the cooperation of the leading European men of science. The Preliminary World Committee includes in a list of several hundred the names of Arrhenius, v. Babes, Bang, Bertillon, Ehrlich, E. Fischer, Flügge, R. Hertwig, van't Hoff, Landouzy, Ledue, Lockyer, Madsen, Metchnikoff, Oppenheim, Ostwald, Ramsay, Richet, Roux, Rubner, Salomansen, Sanarelli, Schuster, Scott-Sherington and Waldeyer. In the United States he has already secured the adhesion of J. McKen Cattell, Harvey Cushing, George Dock, E. Dana Durrand, John S. Fulton, George E. Hale, W. G. MacCallum, S. N. D. North, Henry Fairfield Osborn, E. C. Pickering, Ira Remsen, Charles D. Walcott, W. H. Welch and many others.

These efforts deserve the cordial support of American men of science, both for the practical service which the proposed permanent international bureaus would render to their respective sciences and arts and for their beneficent effect upon the movement for peace and for the progressive organization of the world.

C.-E. A. WINSLOW

AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK

SCIENTIFIC NOTES AND NEWS

DR. SIMON FLEXNER, director of the Rockefeller Institute for Medical Research, has sailed for Europe to give the Harben lectures before the London Institute of Public Health and the Cameron lecture at Edinburgh University.

ON account of illness Professor Josiah Royce, of Harvard University, has been compelled to give up the course of Bross lectures

on "The Sources of Religious Insight" and has been given leave of absence for the present academic year.

PROFESSOR W. A. NOYES, director of the chemical laboratories of the University of Illinois, has been granted leave of absence to go to Berlin as the representative of the American Chemical Society at the International Conference of Chemical Societies.

THE directors of the Bache Fund of the National Academy of Sciences have voted a grant of \$500 to Professor M. A. Rosanoff, of Clark University, in aid of his research on the dynamics of sugar inversion.

THE Sarah Berliner research fellowship for women has been awarded to Miss Marie Gertrude Rand, of Brooklyn, a doctor of philosophy of Bryn Mawr College, for her work on the psychology of vision.

DR. GUSTAV HELLMANN, director of the Meteorological Bureau in Berlin, has been elected a member of the Berlin Academy of Sciences.

SIR EDWIN RAY LANKESTER has been elected an honorary student of Christ Church, Oxford.

DR. CHARLES CHILTON, professor of biology at Canterbury College, New Zealand, has been granted leave of absence for 1912, and will spend the year in Europe visiting biological laboratories and stations.

PROFESSOR FREDERIC B. LOOMIS, of Amherst College, Waldom Shumway, '11, and Philip L. Turner, '12, members of the Amherst biological expedition to South America, arrived at Amherst last week from Buenos Aires. The party left this country last July and has been occupied in the exploration of practically unknown territory in southern Patagonia. A large collection of fossil remains has been obtained.

PROFESSOR T. A. JAGGAR, JR., of the Massachusetts Institute of Technology, has been granted leave of absence for the remainder of the year that he may perfect the plans for the Volcanic Laboratory at Halemaumau in the Hawaiian Islands. This observatory has been

in the charge of Professor Perret during the past summer.

PROFESSOR F. O. GROVER, head of the department of botany of Oberlin College, devoted a portion of the summer recess to work on Monhegan Island, Maine, where he discovered several unknown plants and extended the known distribution of other species. His most important find was a specimen of *Carex crinita porterei*, which has not been seen by botanists since its discovery at Moosehead Lake in the early seventies.

PROFESSOR ERICH VON DRYGALSKI, of Munich, leader of the German South Polar Expedition, has been entrusted by the Prussian Academy of Sciences with the continuation of the explorations in China begun by the late Professor Ferd. von Richthoven.

DR. MARCUS BENJAMIN, of the U. S. National Museum, has been appointed by the president to serve on the Assay Commission that meets in Philadelphia on February 14.

UNDER the auspices of the College of Sciences, a series of lectures will be given at the University of Illinois by Professor W. Johannsen, of the University of Copenhagen, on "Modern Problems of Heredity." These lectures will be given from February 26 to March 2, 1912. The first lecture at the University of Illinois will be an introductory one on such topics as "The Primitive Conception of Heredity." "Transmission" of Personal Characters," etc. The second on "The Principle of Pure Lines." The third lecture, "Mendelism." The fourth, "Complications and Exceptions." The fifth, "Mutations." The sixth lecture, "Continuity or Discontinuity in Evolution." From March 4 to 10 a series of five or six lectures will be given, also under the auspices of the College of Science, by Professor W. Kuenthal, of the University of Breslau.

On January 16 Professor W. Bateson began a course of six lectures at the Royal Institution on "The Study of Genetics."

PROFESSOR V. VOLTERRA, of the University of Rome, is giving a series of lectures at the University of Paris on the extension of the

theory of functions, the integro-differential equations and integral equations, with applications.

THE Moissan memorial lecture before the London Chemical Society will be delivered by Sir William Ramsay, on February 29.

PROFESSOR W. JOHANNSEN, of the University of Copenhagen, gave an address on "Problems of Heredity" before the Minnesota chapter of Sigma Xi on the evening of February 10.

PROFESSOR A. V. BLEININGER, of the University of Illinois, delivered a series of lectures on the theory and technology of clays and other silicates, before the classes in economic geology of the University of Chicago, January 22-27.

DR. W. A. HEIDEL, professor of Greek at Wesleyan University, gave an address on "The Beginnings of Science" before the Middletown (Conn.) Scientific Association on February 13.

EDWARD M. EAST, assistant professor of experimental plant morphology, Bussey Institute, Harvard University, lectured at Trinity College on the evening of February 16 on "Influences of Recent Advances in Biology in the Art of Plant Breeding."

PROFESSOR M. A. ROSANOFF, of Clark University, lectured on February 1 and 2 before the industrial research fellows at the University of Pittsburgh on "The Partial Vapor Pressures of Liquid Mixtures."

MR. HAROLD PARKER, on February 9, delivered a lecture on "Contracts and Specifications" before the graduate students in highway engineering at Columbia University.

THE senior class of the Colorado School of Mines has recently been given addresses by professional men of Denver. Mr. Frank E. Shepard, president of the Denver Engineering Works Co., spoke on "Modern Mill Practice" and on "Modern Mill Plant Design"; Mr. John C. Traylor, of the Traylor Engineering Works, spoke on "Jigging," and Mr. W. H. Trask, consulting engineer for the Cen-

tral Colorado Power Co., spoke on "Modern Hoisting Installations."

PROFESSOR W. E. CASTLE has returned from the expedition which he recently made to Peru under the auspices of the Carnegie Institution of Washington, having succeeded in obtaining from two different localities, one in southern and one in central Peru, wild cavies supposed to be closely related to the domesticated guinea-pig. These will be used in breeding experiments at the Bussey Institution. The event is of interest to zoologists as being probably the first introduction of living individuals of the ancestral guinea-pig into North America or Europe. This fact is the more surprising when it is remembered how extensive and important is the use of the guinea-pig in biological investigation and the public health service. Not only is the wild guinea-pig unrepresented in any zoological garden, but even our greatest museums possess scarcely a specimen of it. The transportation of the animals for several thousand miles through a variety of climatic conditions involved some difficulties, which, however, were all successfully met. Small round market-baskets lined with wire netting served as cages, and cucumbers and watermelons for food during transportation through the tropics. Some domesticated guinea-pigs were also obtained from Peruvian natives for comparison with the ordinary European sorts, which probably reached Europe from South America centuries ago.

A COMPREHENSIVE project for research on the Cactaceae has been organized by the department of botanical research of the Carnegie Institution of Washington. Dr. J. N. Rose, of the U. S. National Museum, who has explored much of the region inhabited by these plants in Mexico and the United States and published extensively on the family, has been appointed research associate. He has been granted a furlough from the museum, which also furnishes working quarters and facilities for handling the living collections. Dr. N. L. Britton, who began organizing a collection of cacti in the New York Botanical Garden

in 1900, and has since made extensive studies of the group, has also been appointed research associate, without salary. By the action of the scientific directors of the garden he will be given some respite from other duties to enable him to participate in this work. The garden also contributes its extensive collections, and some of its explorational effort to the project. Dr. D. S. Johnson, of Johns Hopkins University, will spend several in 1911 on the morphology and physiology of the fruits of the group, and Professor J. G. Brown, of the University of Arizona, will continue his studies on the general morphology of *Opuntia* and *Carnegiea* begun while acting as assistant at the Desert Laboratory. Other contributions will be made by the members of the staff and cooperators of the Desert Laboratory.

THE fifth annual meeting of the Illinois Academy of Science will be held at Bloomington, Illinois, Friday and Saturday, February 23 and 24, under the auspices of the McLean County Academy of Science. The sessions will begin at 2:00 P.M. on Friday and will continue through Saturday afternoon. A symposium on Conservation will be given at the Saturday morning session, the speakers and their subjects being as follows:

"Conservation of Our Coal and Oil," F. W. DeWolf, director, Illinois State Geological Survey.

"Water Pollution," Edwin O. Jordan, professor of bacteriology, University of Chicago.

"Conservation Ideals in the Improvement of Plants and Animals," Herbert J. Webber, professor of plant breeding, Cornell University College of Agriculture.

"Conservation of Our Forests," Henry C. Cowles, associate professor of ecology, University of Chicago.

"Conservation of Our Fauna," S. A. Forbes, director, Illinois State Laboratory of Natural History.

"Conservation of the Human Race," J. N. Hurty, secretary, Indiana State Board of Health.

A banquet will be given at the Illinois Hotel on Friday evening, after which the president, Professor W. A. Noyes, will address the academy, the subject being "The Electron

Theory." Many papers of scientific and educational interest will be presented during the sessions.

A COURSE of six lectures under the auspices of the Chicago Nature Study Club is being given at the Academy of Science, Lincoln Park, on Saturday afternoons at 1:30 as follows:

February 10—"Schoolroom Aquaria," Frank C. Baker, curator, Academy of Science.

February 17—"Window Gardening," Aaron H. Cole, Chicago Teacher's College.

February 24—"Beautifying the Schoolyard," Jens Jensen, landscape architect.

March 2—"Trees for the Schoolyard, Street and House, How to Select and Care for them," J. H. Prost, city forester.

March 9—"The Enemies and Diseases of Trees," J. H. Prost, city forester.

March 16—"Birds as Guardians of Trees and other Plants," R. M. Strong, University of Chicago.

We learn from *Nature* that it is proposed to establish in Dartmouth a permanent memorial to Thomas Newcomen, known for his work in connection with the steam engine, who was born in that town in 1663. A meeting of those interested in the matter has been held in the Dartmouth Guildhall. The mayor of Dartmouth, Mr. Charles Peek, and Mr. T. F. Caston, the honorary secretary to the Newcomen Memorial Committee, will welcome suggestions as to the best manner of perpetuating the memory of the inventor and his invention, and be glad to receive contributions.

THE late Dr. A. S. Packard, of Brown University, planned a series of illustrated volumes on the bombycid moths of North America, to be published by the National Academy. Two volumes were issued during his lifetime. Materials for a third volume, on the large silk-producing moths, were left and these have been placed in the hands of Professor Cockerell, of the University of Colorado, who is editing them for publication.

DR. FRANCISCO P. MORENO, member of the chamber of deputies, Argentina, has introduced a motion in the congress of Argentina for the acquisition by the government, for the

Museo Nacional at Buenos Aires, of the great private paleontological collection of Florentino Ameghino.

MR. JOHN D. ROCKEFELLER has given \$11,000 toward the purchase of the house in which Pasteur was born in the village of Dôle.

PROFESSOR HENRY WILLIAMSON HAYNES, known for his investigations in archeology, died at his home in Boston on February 15, aged eighty years.

DR. HENRY TAYLOR BOVEY, F.R.S., from 1887 to 1909 professor of civil engineering and applied mechanics in McGill University, first rector of the reorganized imperial College of Science and Technology in London, died on February 2, aged fifty-eight years.

SIR HENRY TRENTHAM BUTLIN, Bart., a leading English surgeon and pathologist, died on January 24, aged sixty-six years.

SIR JOHN CHARLES DALRYMPLE HAY, Bart., F.R.S., admiral (retired) of the British navy and the author of books on naval topics, died on January 28, at the age of ninety years.

M. T. DURAND, member of the Royal Academy of Belgium, director of the State Botanic Garden and general secretary of the Royal Botanic Society of Belgium, died on January 12.

THE death is announced of Dr. L. Pič, the noted Bohemian archeologist, in charge of the unsurpassed archeological collection of the Museum Regni Bohemiae, Prague.

DR. OTTO LIEBMANN, formerly professor of philosophy in the University of Jena, has died at the age of seventy-one years.

THERE will be a New York State civil service examination on February 24, the positions opened including that of first assistant veterinarian in the Department of Agriculture at a salary of \$1,800 to \$2,400, and bacteriologist in the Health Officers' Department, Quarantine, New York, at a salary of \$1,500. The latter position is for women.

THE most notable map publication of the year is the large geologic map of North America just issued by the United States Geological Survey. It represents an exceptional

type of engraving and lithographic color work and is printed in four sheets which fitted together and mounted make a map 6 feet 5 inches high by 5 feet wide, the largest piece of work ever issued by the survey. The scale is 1 to 5,000,000, or 80 miles to the inch, and the plan of projection is in harmony with the universal world map on a scale of 1 to 1,000,000, in that it shows the units of publication of the world map, each of which embraces four degrees of latitude and six degrees of longitude. The color scheme of the map is a striking one. In all there are 42 color distinctions, varying from a brilliant red to pale tints approaching white. These were produced by 14 separate printings from lithographic stones, requiring in many places two or three combinations of color to produce the desired effects. If the weight of paper and heavy stones lifted back and forth in the printing of this job were to be computed it would run into the hundreds of tons. The accuracy of the "register," or fitting together of the color blocks in small areas throughout the map, is remarkable. The work was done in the survey's own engraving and printing plant, and it is believed that there are few if any other establishments in the United States capable of turning out such a production. The 42 color distinctions represent as many divisions of rock strata. Thus the rocks of seven divisions of the Paleozoic era are each represented by a color, besides three separate colors for undifferentiated rocks, and there are other colors for the division of the Mesozoic, the Tertiary and the Quaternary. The coloring of the map is both effective and pleasing. The scheme is systematic in that the colors range in prismatic order from yellow in the upper portion of the geologic column through greens, blues and purples to pinks and browns at the base. The colors for the igneous rocks, both plutonic and volcanic, are mostly bright red. Viewed as a wall map, the map of North America shows only the larger geologic units, as the smaller divisions are represented by different shades and tints of the same or closely allied colors which are indistinguishable at a moderate distance.

THE *Journal* of the American Medical Association quotes from the *Journal Officiel* data of the vital statistics in France for the first semester of 1911. There were almost 14,000 fewer births than during the corresponding semester of 1910. Last year the births, which were few enough already, amounted to 399,669. This year there were not more than 385,999. While births diminished, deaths increased. They increased from 378,480 during the first semester of 1910, to 404,278 during the first semester of 1911, an increase of 25,798. During the six first months of the current year the deaths exceeded the births by 18,279. The number of marriages has decreased in a slightly less proportion. There were about 156,761 last year. There are not more than 153,931 this year. Divorces, which last year amounted to about 6,303, in 1911 have increased to 6,374.

THE fourth report of the royal commission on university education in London deals with the housing of London University. According to the London *Times* the commissioners state that it had become clear, as the inquiry proceeded, that the inception of any scheme which they might be able to recommend and which parliament might sanction would be seriously delayed unless some steps had previously been taken to provide for the university, as reconstituted, a site and buildings more convenient and adequate than those it now occupied. They think that whatever its future constitution might be, it was a matter of national importance that the University of London should be recognized and adopted as a great public institution; and that it was fitting and right that such an institution should have for its headquarters permanent buildings appropriate in design to its dignity and importance, adequate in extent and specially constructed for the purpose, situated conveniently for the work it had to do, bearing its name, and under its own control. The University of London, it is stated, must depend, like other universities, to a large extent, for the liberal support necessary for its full development upon the endowment of private benefactors. The commissioners thought such benefactors

were to be found; and the inquiry had impressed them so forcibly with the almost unlimited possibilities of the university in the future, that they could not easily conceive a more splendid opportunity than its endowment and the provision of a noble and suitable building for its home afforded for the liberality of the citizen.

ATTENTION is called in the *London Times* to the fact that every year the London Zoological Gardens are visited by large numbers of school children, accompanied by their teachers. The price of admission for these is one penny, and the time spent on the visit is counted as school attendance. The council of the society desired to make these visits more useful, and last year arranged with the education committee of the London County Council for a series of demonstration lectures to school teachers. The Zoological Society arranged the courses, provided the lecture-room and lantern and allowed the teachers free admission to the gardens, while the education authority made a grant towards the expenses. The course, which was repeated three times last session to three separate sets of 150 school teachers, consisted of three lectures illustrated by lantern slides and a demonstration in the gardens, for the latter the teachers being divided into parties of 25. This session it was considered advisable to increase the number of demonstrations in the gardens, and the education committee has increased their grant to make this possible. The syllabus has been made very simple and is devised to cover only such subjects as may be made interesting to school children. In the case of mammals the main types, such as carnivores and herbivores, are considered in relation to their food and modes of obtaining it, their weapons of offence and defence and their chief adaptations to their environment. Birds are similarly treated, but the nesting habits and the care of the young are discussed more fully. The coloration of animals in relation to deserts, snow and so forth are dealt with, and salient examples of mimicry and warning patterns and colors are pointed out. In the demonstration tours in the gardens examples of the questions dis-

cussed in the lectures are pointed out. The first lecture for the season was attended by nearly 150 teachers, while four parties of 25 teachers were taken for a demonstration tour in the gardens by the lecturer, Mr. J. L. Bonhote, and his assistant, Mr. J. T. Cunningham. To suit the convenience of teachers, all the lectures and demonstrations are given on Saturday mornings, and the three courses now arranged for will last well on into the early summer of next year.

THE first All-Slav Congress and Exposition of Social Medicine and Hygiene will be held in St. Petersburg during the week commencing May 28, 1912. There will be five sections, the first of which (president, V. O. Gubert), will deal with medicine and hygiene of the masses; the second (president, J. F. Zemackij), with gymnastics and exercises tending towards the better development of the body; the third (president, M. M. Kovalevskij), with social ethics; the fourth (president, A. V. Vasiljev), with the development and health of the child, and the fifth (president, D. O. Ott), with the woman. More in detail, Section 1 will deal with regulation of the medical aid; hygiene of houses and cities; housing problems; nourishment, with price of food; social and hygienic protection of workingmen; combat of prevalent diseases; protection of the mental health of the population; medical education and activities, and cure establishments, springs, etc., with balneotherapy. Section 2 embraces physical exercises; the Sokols (the great Slav gymnastic organization); athletic contests and sports; touristic, and bathing, with swimming. Section 3 deals with abuse of alcoholic beverages; dissipation and specific diseases; suicide, and criminality. Section 4 extends to development of the child; health in infancy; infant mortality; training of the child before school age; school hygiene, and mental development of the child. Section 5, finally, embraces everything relating to the functions and health of the woman.

THE *American Museum Journal* states that in revising the installation of the New Guinea material in the South Sea hall, Dr. Lowie is making extensive use of the sketches secured

by the museum with the Finsch collection. Dr. Otto Finsch, the celebrated naturalist and traveler, provided with the collection a very full series of illustrations accurately picturing many phases of native life. These are highly desirable, as many aspects of aboriginal culture, such as house and boat types can not always be readily transported or even secured in model specimens, although often they form the most characteristic elements of the culture of a tribe. This applies even more emphatically to social and ceremonial life, which can be studied very inadequately, if at all, from museum specimens. It also applies in large measure to objects of personal adornment and clothing. For instance, it would not be at all obvious to the average visitor how the aborigines wore a profusely decorated heart-shaped object conspicuously exhibited in one of the New Guinea cases. A glance at the sketch now beside the specimen shows it to be a warrior's breast ornament. Similar results have been accomplished with other articles of dress which otherwise could not readily be understood except with the aid of long explanatory labels.

THE London *Times* states that in the old parish church of St. Mary, Teddington, a tablet has recently been dedicated to the memory of the Rev. Stephen Hales, D.D., a former vicar of the parish and one of the most distinguished men of science of the eighteenth century. A number of eminent living *savants* have for a long time been endeavoring to discover his burial place, in order to preserve his memory, and at length the stone recording his death was found in the floor of the porch of the church with nearly the whole of the lettering obliterated. The new tablet has been placed on the wall of the west porch beneath the tower of the old church, and bears the following inscription:

Beneath is the grave of Stephen Hales. The epitaph, now partly obliterated, but recovered from a record of 1795, is here inscribed by the piety of certain botanists, A.D. 1911. "Here is interred the body of Stephen Hales, D.D., Clerk of the Closet to the Princess of Wales, who was minister of this parish 51 years. He died 14th January, 1761, in the 84th year of his age."

Mr. Francis Darwin has written for the current number of the *Parish Magazine* an interesting account of Dr. Hales, in the course of which he says: "Stephen Hales has been called the 'father of physiology,' and he deserves this title in regard both to animals and plants. His experiments on the blood pressure of animals are second only to Harvey's work on the circulation. In the domain of plant physiology he is equally great. In all his researches he combined a belief in the design of the Creator with a passionate desire to understand the mechanism of living things. Thus he treated the manifestations of life as things to be weighed, measured and analyzed in the laboratory. It is this point of view that gives his work so modern a character and entitles him to be considered one of the founders of a rational science of biology. Although he loved science for its own sake, it is equally clear that he was dominated by a permanent desire to use his knowledge for the benefit of his fellow-creatures. Water supply, ventilation, the distillation of potable water at sea, the preservation of food on long voyages, the treatment of at least one disease—the stone—and especially the harm arising from intemperance in the use of alcohol, all received attention. It is impossible to read his works without mingling personal affection with the respect inspired by his intellect."

UNIVERSITY AND EDUCATIONAL NEWS

AFTER long preparation, ground has been broken for the first Reed College buildings on the campus of eighty acres. The college will open next September in the permanent buildings, and on the endowment foundation of about \$3,000,000 provided by Mr. and Mrs. Simeon G. Reed, of Portland. Three buildings, in addition to residences for the faculty, will be ready—the arts building, the dormitory and the gymnasium. All the buildings will be in the collegiate-gothic style of architecture. The material will be Indiana limestone and mission brick. The arts building and dormitory will be of steel and concrete structure, fireproof throughout. The buildings will run against the wooded ravine and lake, which

are picturesque features of the campus. The arts building is 257 feet long, with wings 85 feet long. It has four stories. The estimated cost of the building and furnishings is \$225,000. The dormitory, which is virtually five separate dormitories, contains a large clubroom for men students, a dining-hall and rooms and baths for 125 students. The cost of this building, exclusive of furnishings, is \$140,000.

The plan of George M. Pullman for the establishment of a manual training school at Pullman, Ill., is assuming definite form. Professor L. G. Weld, formerly professor of mathematics and dean of the University of Iowa, has been despatched on a tour of America and Europe to collect data to guide the board of trustees in the construction of the buildings and the arrangement of the curriculum. Building operations, it is expected, will be commenced next year. A site of forty acres has been purchased at a cost of \$100,000. A fund of \$1,000,000 was bequeathed by Mr. Pullman at his death on October 18, 1897, for founding the institution. This fund was invested in securities which have increased in value until now there is about \$2,500,000 at the disposal of the directors for the school.

THE University of California announces the establishment by Mr. F. M. Smith, of Oakland, California, of a research fellowship for investigation of certain problems incident to the growth of cities in the San Francisco Bay region. Attention is to be directed especially to questions relating to the development of parks, playgrounds and other community interests demanding particular consideration of space available for growth. The stipend of the fellowship is \$1,000 per annum, and an additional sum of \$500 annually is provided for expenses of the investigation. The work of the fellow will be conducted under the supervision of a special committee named for this purpose, and the results worthy of record are to be prepared for publication.

\$12,500 was recently turned over to the authorities of the Colorado School of Mines for the equipment of the new ore testing plant. The building for the plant was built a year

ago and \$50,000 was allowed by the legislature for the necessary machinery and one fourth of this is what is now available. Many donations of machinery have been made by the various manufacturers and it will now be possible to completely equip, ready for operation, the concentration section of the plant.

DR. J. B. HURRY has established a research studentship of physiology at Cambridge to be named in honor of Michael Foster.

We learn from the *Bulletin* of the American Mathematical Society that Dr. G. Schirmer, a Chicago physician, has established at the University of Erlangen, a prize fund, to be known as the Helene Ottilie Schirmer foundation, in honor of his late wife. The income, \$150, is to be given to the author of the most meritorious thesis prepared at the university during a period of two years preceding each award; the subjects are to be in mathematics or physics in odd years, and in medicine in even years. The first award has recently been made to Dr. R. Baldus for his dissertation on certain line congruences.

Two new departments are to be established at Swarthmore College next year, one in political science, and the other in psychology and education. Dr. Robert C. Brooks, at present professor of political science at the University of Cincinnati, is to head the political science department, and Dr. Bird T. Baldwin, now professor of education at the University of Texas, will have charge of the work in psychology and education.

DR. C. N. JENSEN, fellow in plant pathology, Cornell University, has been appointed professor of botany and plant pathology in Utah Agricultural College and Experiment Station and entered on his duties on February 1.

DR. ELEANOR H. ROWLAND, professor of philosophy at Mt. Holyoke College, has resigned to become dean of women and professor of philosophy at Reed College, Portland, Ore., but does not enter upon her new duties until next September. She will spend the next semester in Crete, engaged upon research work. Dr. Kate Gordon takes Dr. Rowland's place during the second semester.

DR. SAMUEL P. HAYES, professor of psychology, will be in England until next fall.

MR. C. SHEARER, of Clare College, Cambridge, has been nominated to a newly established lectureship in experimental morphology at Cambridge.

DISCUSSION AND CORRESPONDENCE

THE WORD GENOTYPE

PROFESSOR JENNINGS (*SCIENCE*, December 15, p. 847) refers to the fact that the word genotype has two meanings, but does not make it quite clear that both are current at the present time. The use of the word, with a definition, by Schuchert antedates that of Johannsen, as has been several times pointed out. Taxonomists can hardly be expected to abandon their prior and useful term, so it becomes a question whether it is convenient to continue the Johannsenian usage, trusting to the context to indicate in every case what is intended.

Some months ago, in conversation, my colleague, Dr. George Norlin, suggested "amictotype" as a possible substitute for genotype in the sense of Jennings.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

GENOTYPE AND "GENOTYPE"

"IN calling attention to the frequent misuse of the word 'genotype'" (quotation from George H. Shull in *SCIENCE*, February 2, 1912, p. 182), the students of heredity will please take notice that this term has been in biology since 1897 and that Shull, Johannsen and others persistently misuse the term. The original definition is as follows:

"*Genotype* (*genos*=race, and *typos*=type).—Genotype applies to any *typical material of the type species of a genus*. The material, however, should be, if possible, from the original locality of the species, or a genotype should also be a toptype or a metatype. Therefore there may be as many genotypes of *Lingula* as there are museums having characteristic specimens of *Lingula anatina*."¹

CHARLES SCHUCHERT

¹ *SCIENCE*, April 23, 1897, p. 639.

SCIENTIFIC BOOKS

Lectures on Fundamental Concepts of Algebra and Geometry. By JOHN WESLEY YOUNG, Professor of Mathematics in the University of Kansas. Prepared for publication with the cooperation of WILLIAM WELLS DENTON, Assistant in Mathematics in the University of Illinois. With a Note on the Growth of Algebraic Symbolism by ULYSSES GRANT MITCHELL, Assistant Professor of Mathematics in the University of Kansas. New York, The Macmillan Company. 1911. Pp. vi + 247.

Descriptive Geometry: A Treatise from a Mathematical Standpoint. By VICTOR T. WILSON, M.E., Professor of Drawing and Design in the Michigan Agricultural College. New York, John Wiley & Sons. 1909. Pp. viii + 237.

Elements of Descriptive Geometry with Applications to Spherical and Isometric Projections, Shades and Shadows, and Perspective. By ALBERT E. CHURCH, LL.D., late Professor of Mathematics in the United States Military Academy, and GEORGE M. BARTLETT, M.A., Instructor in Descriptive Geometry and Mechanism, University of Michigan. New York, American Book Company. 1911. Pp. 286.

Professor Young's "Lectures" presuppose in the reader intellectual acumen and a certain logical bent but little mathematical knowledge beyond the elements of algebra and geometry. Dealing with such topics as Euclid's Elements, A Non-Euclidean World, Consistency, Independence and Categoricalness of a Set of Assumptions, with the notions of class, correspondence and group, the assumptions of Hilbert and Pieri, dimensionality and hyperspace, variable, function and limit, and dealing with them in a way that is at once philosophic, romantic, scientific and well-nigh literary, the lectures ought to appeal to a wide and diversified class of readers, philosophers, logicians, both expert and inexperienced mathematicians, and thinkers in general. The book is far more than its title indicates, for the concepts treated are presented as being fundamental to mathematics in general, to

mathematics regarded as "the universum of exact thought," rather than to algebra and geometry conceived as special branches thereof. Basic concepts and central concepts, though the two categories may intersect, are in general not the same, else the book would doubtless have admitted to a prominent place the notion of invariance, a notion that, besides being of central importance in mathematics, serves to ally the interests of this science with those of science in general, and with those of philosophy, theology, religion and art. It is the chief unifier of the great forms of human interests and endeavor. Professor Young has admirably shown that any science must contain two sorts of ideas, the assumed and the defined; besides these it uses ideas that it does not contain (as subject matter); the like is true of propositions; somebody ought, in respect of some science, to assail the problem of indicating those ideas that are used by the science without being a part of its content. In the chapter dealing with "the logical significance of definitions" Professor Young might well have said, what he doubtless knows, that, for example, the notion of definition is no part of the subject matter of logic or mathematics, though for the sake of convenience the notion is continually there in use. The conception of mathematics presented in italics on page 221 leaves the science without any unity except such as belongs to a mere collection, which can never satisfy. The defect is partly cured on page 225. In a democracy it is a duty of scholars to render scientific concepts intelligible to the public intelligence, and Professor Young's book is a valuable contribution to such high service.

The descriptive geometry treated by Professor Wilson and Professor Bartlett is not to be confounded with that great variety of geometry, called descriptive by Russell and others, which was founded by Pasch in his "Vorlesungen über neuere Geometrie" (1882) and a few years later cast in symbolic form by Peano, but it is that branch of geometry which has for its object the representation of

3-dimensional figures by means of their projections upon two or more planes, a method invented by Gaspard Monge (a peddler's son) in response to military exigencies in France and set forth by him in 1800 in his "Géométrie descriptive." Professor Wilson's aim, "to present a sound theoretical treatment" and not to win the student by means of mere appeal to "short cuts" and his "practical" interest, is laudable. As to the extent to which the end has been attained, some mathematicians may be disappointed in not finding here a system of postulates. On the same page (2) we are told that parallel lines are said to have two points in common at infinity, that parallel planes meet each other in a common line at infinity, and that descriptive geometry and perspective are a part of projective geometry. The traditional use of "line" for curve is adopted. Two consecutive points are regarded as points "infinitely close" together but not coincident (p. 81) and as coincident points (p. 93). The statement that "the secant approaches tangency and become such when the two points [of secancy] become coincident" will serve (even after typographical correction) to exemplify a not infrequent occurrence in the book of unprecise statement. One can not but feel that so good a book ought to be better. Typographically and mechanically it is pleasing; there is appended a goodly list of exercises; and the point of view is somewhat more general than is common in American text-books in this subject.

When will some breath of modern mathematics get into our text-books of descriptive geometry? Church's "Elements," published in 1864, has reigned, partly because of its merits, for nearly five decades. To meet the new demands in respect of matter and of presentation, Professor Bartlett has not deemed it necessary to depart essentially from the venerable text of Church. Consequently this interesting and instructive new volume has the scientific odor of a geometric past, despite the excellence of the drawings and pictorial representations of certain more

difficult problems. On page 63 we are invited to think of a moving point as going from one position to the "next." Two points thus next to each other form an infinitely small straight line. The two points are consecutive, without distance between them, and "may practically be considered as one point." No talk about limit: a curve is, for thought, composed of infinitely short straight lines. The term locus does not appear except incidentally as on page 84. But "if a point moves so as continually [not continuously] to change its direction from point to point, the line generated is a curved line, or curve." According to the highest mathematical standards, descriptive geometry has not attained, in America, to the rank of a science. It is a tool. Judged as a work designed to teach the use of an important tool, Professor Bartlett's book will render good service. But such books ought to get up-to-date in respect to logic, geometric spirit, conception and nomenclature.

COLUMBIA UNIVERSITY

C. J. KEYSER

Les Poissons Wealdiens de Bernissart. By RAMSEY H. TRAQUAIR, M.D., LL.D., F.R.S. Extrait des Mémoires du Musée Royal d'Histoire Naturelle de Belgique, T. VI. Bruxelles. 1911. 4to. Pp. iv + 65; 12 pls. and 21 text figures.

In this memoir Dr. Traquair—the dean of paleichthyologists—discusses the fishes of the Wealden, or basal Cretaceous, of Belgium. This formation, though known chiefly for fine skeletons of the dinosaur *Iguanodon*, contains also a highly interesting fish-fauna. This is remarkable for the fact that its species, though relatively few (sixteen), represent both the more archaic members of the group of ganoids as well as the quite modern teleosts. In discussing this fauna, therefore, Dr. Traquair has opportunity of reviewing at once such forms as *Coccolepis*, the last survivor of the Palæoniscidæ, as well as *Leptolepis*, the earliest of the clupeoids.

The memoir is of necessity devoted mainly to systematic details; none the less broader questions, such as those of morphology, relationship and geological distribution, are not

overlooked. And all these themes are treated with the author's characteristic painstaking regard to fact. In short, the memoir is an example of what a systematic review of a fossil fauna should be.

An interesting and very useful feature is the carefully drawn restorations, of which there are thirteen. Especially noteworthy are those of *Coccolepis*, *Callopterus*, *Amiopsis*, *Mesodon* (with new interpretations of the cranial elements) and *Aethalion*. These figures are sure to follow the many others from the same hand, and become part of the stock in trade of all writers on ichthyology.

The fauna of Bernissart, as a whole, is regarded as fresh water. The chief evidence for this view is the entire absence of sharks from this formation, although the group is abundantly represented in other European rocks of equivalent age.

To the friends of Dr. Traquair—and they are many, both in Europe and America—the publication of this memoir has an especial interest. For it shows the doctor, who is past his seventieth anniversary, still working away, with his old-time vigor and enthusiasm, in the field which he has done so much to advance.

Ave Magister! Many be the years

That lie before thee, thronged with busy hours!¹

L. HUSSAKOF

AMERICAN MUSEUM OF NATURAL HISTORY

THE HARRIS TIDAL MACHINE

THE Coast and Geodetic Survey has recently put in operation, after a thorough test, a new tide-predicting machine, which performs simultaneously all the operations of the British or Thomson machine and of the first American machine invented by Professor Ferrel. As in the Thomson machine, the tidal curve is drawn from which the height of the tide at any time may be scaled off, but, in addition to this, the times of high and low water are marked upon its axis, and both the time and height of the tide, as well as the height of the water's surface at any given

¹Dr. S. Weir Mitchell, "The Comfort of the Hills and Other Poems," p. 95. New York, 1910.

time, are shown upon graduated circular dials on the face of the machine. The machine was invented by Dr. R. A. Harris, who seventeen years ago published a brief but comprehensive description and submitted a general plan to the Coast Survey Office. (See report of superintendent for 1894.) The details of the machine-design were worked out by Mr. E. G. Fischer, under whose direction the machine was set up in the instrument division of the survey.

Mechanical aids of this kind are used in connection with the tides, because good predictions require the combination of a considerable number of sine or cosine terms whose arguments vary uniformly with the time. The new machine contains 32 short-period components (*i. e.*, daily, semi-daily, quarterly, etc.) and 7 having long periods (*i. e.*, fortnightly, monthly, semi-annual and annual.

In combining these numerous terms two summations are carried on continuously by means of two chains each fixed at one end and free to move at the other. Each chain is laid alternately over and under a series of pulleys whose upward and downward movements cause the free end of the chain to travel back and forth across a fixed initial point. The motion of the free end of one of the chains is proportional to the rise and fall of the tide to be represented or predicted; that of the free end of the other chain (or rather of a marked link a certain distance from this end) is such that when this link passes across a fixed point the height represented by the first chain is at its maximum or minimum value. These statements describe very briefly the general plan upon which the times and heights of the tides are mechanically determined. As already stated the times and heights are shown upon the face of the machine while a curve is drawn which makes a permanent record of all stages of the tide.

The machine is driven by hand and the gears are such that the periods of motions which depend upon them shall represent the known periods of the various sine and cosine terms into which tidal records or observations can be resolved.

In the new machine the error resulting from the representation of the incommensurable astronomical ratios by the gears amounts to less than one degree for a period representing a year in prediction. For the larger terms the error is much less, so that after predicting a year's tides and reading hourly heights for December 30 and 31, the predicted values agreed so well with the values computed directly from astronomical data, as to make the errors negligible.

It may be stated that, although tide-predicting is the most useful purpose to which the machine is put, its broadest application is in the solution of equations of the form $y = H_0 + A \cos (at + \alpha) + B \cos (bt + \beta) + \dots$, where A, B, C, \dots denote the amplitudes and a, b, c, \dots their speeds per unit of time t , of which it draws the graph and indicates the positions and magnitudes of the roots.

SAMUEL TIERNEY, JR.

SPECIAL ARTICLES

XERALEXIS

WHOEVER brings forward a new word must show what the students in journalism would call a "crying need" for it, or take the consequences. The undersigned is not altogether certain as to how crying the need may appear to others, but it seems to him that a single euphonious, appropriate word should be sought to replace the clumsy and rather ill-sounding compound, "drought-resistance." The writer proposes the coining of the word *xeraléxis*, from the Greek ξηρότης, drouth, and ἀλέγξαις, a keeping off or resistance.

We have, of course, the words, "xerophytic" and "xerophytism," which do not, however, involve the idea of resistance to drouth in their composition, and do not convey that meaning in usage, although it stands to reason that a "drouth-resistant" plant will have "xerophytic" characteristics of some kind.

There is ample justification for the new word on etymological grounds. The Greeks had many compounds in which the above roots were employed. The root of the adjective *xēros*, "dry" and *xērōtēs*, "drouth," is found

in *xerophthalmia*, a dryness of the eyes; *xerobiotikós*, living on dry land; *xerophagia*, the eating of dry food, etc.

The root of the word *aléxein*, "to ward or keep off, to turn away or aside," and *aléxisis*, "resistance or warding off," is found in such combinations as *alexanemia*, "shelter from the wind," or where Sophocles in the *Œdipus*, uses the adjective *aleximoros*, "warding off fate or death" (*móros*). Hipparchus uses *alexipharmakos*, in the sense of "warding off poison," or "acting as an antidote."

So the examples might be multiplied. It is strange that the Greeks did not themselves coin a word for "drouth-resistance," for they had and have an abundance of drouth to resist in Hellas, as any one who has ever been there in the summer-time can abundantly testify. It would be interesting to investigate modern Greek terminology on this point.

A euphonious compound of the two above roots can only be made by putting the root for drouth first; although the Greek tendency in the formation of compounds involving *aléxein*, in the sense of "warding off," "defending," seems to put the latter first, as in *Aléxandros* (Alexander)—defender of men (anér, man)—in the examples given above, and many others. To follow this practise and coin such a word as *alexixerótēsis* might be possible for a Greek, but not for us.

Let us accordingly turn the roots around. We then find that we have available for the first member of the compound, two possible nouns, viz., *aléxēsis* (ἀλέγησις)—"a keeping off" or "resistance," and *aléxis* (ἀλέξις)—"help"—both from the same root as the verb *alexéo* or *aléxō* (ἀλέξω, ἀλέξω), infinitive *aléxein* (ἀλέξω)—a verb which has both the primary signification of to "ward off" or "resist" and the derived one of "to help." Here we encounter a difficulty. If we follow a natural analogy and say *xeraléxis*, following "prophylaxis" from the Greek *phulaxis* (φύλαξις), a "watching" or "guarding," then we seem to imply a derivation from the word *aléxis*, "help," rather than from *aléxēsis*, "warding off." But on the other hand, "*xeraléxēsis*" is slightly longer than

"drouth-resistance." There remains, of course, the possibility of following another valid Greek analogy, and saying *xeraléxia*.

On the whole, however, *xeraléxis* is preferable on the score of brevity and ease of pronunciation. Perhaps we are justified in calling it a "contract form" of "*xeraléxēsis*," if that will satisfy the philologists.

We then have for "drouth-resistance," *xeraléxis* and for "drouth-resistant," *xeraléctic*. In the writer's estimation these words might well replace in botanical language generally, not only our English compound, but the awkward French *résistance à la sécheresse*, or the German *Austrocknungs-resistenz*. At all events the new word is logical—as logical as "ecological" in fact.

H. F. ROBERTS

CRYPTOBRANCHUS ALLEGHANIENSIS, LARUS ATRICILLA AND LARUS MARINUS IN NORTH DAKOTA

In a recent article,¹ Pope has recorded the hellbender (*Cryptobranchus alleghaniensis*) and the laughing gull (*Larus atricilla*) as abundant, and the black-backed gull (*Larus marinus*) as occasional at Devils Lake, North Dakota. These records, if verified, would be of much interest, extending the range of the hellbender to the northwest of that hitherto recognized and bringing the laughing and black-backed gulls from the Atlantic coast far into the interior. In three summers spent in this region, however, I have been unable to verify Pope's records and seriously question their accuracy, both for this reason and because of their inherent improbability.

Franklin's gull (*Larus franklini*) a bird which might readily be mistaken by an inexperienced observer for the laughing gull (*L. atricilla*) is a common breeder in this locality, after the breeding season gathering in large flocks upon the lake. Pope has probably mistaken the ring-billed gull (*Larus delawarensis*) for the black-backed (*L. marinus*). I

¹ Pope, Thomas E. B., "Devils Lake, North Dakota. A Study of Physical and Biological Conditions with a View to the Acclimatization of Fish," Bureau of Fisheries Document, No. 634.

have not taken specimens of the former and hence can not speak positively of its occurrence. It has been recorded, however, by competent field observers,² and since its recognized breeding range includes North Dakota, while that of the latter is the northern Atlantic coast, its occurrence here is far more probable than that of the latter.

The only common salamander in the lake is *Amblystoma tigrinum*, which occurs in considerable numbers. I have seen no specimens of *Cryptobranchus* from the lake, and unless Pope's record is supported by specimens, it must be regarded with grave suspicion.

ROBERT T. YOUNG

UNIVERSITY OF NORTH DAKOTA

THE AMERICAN MICROSCOPICAL SOCIETY

THE meeting of the American Microscopical Society at Washington was purely a business session. The following officers were elected: *President*, Professor F. D. Heald, University of Texas; *First Vice-president*, Professor F. Creighton Wellman, Tulane University Medical School; *Second Vice-president*, Mr. Edward Pennock, Philadelphia, Pa.; *Custodian*, Mr. Magnus Pflaum, Meadville, Pa. Professors A. M. Reese, University of West Virginia; F. C. Waite, Western Reserve Medical School, and W. F. Mercer, of Ohio University, Athens, Ohio, were chosen elective members of the executive committee. Professor T. W. Galloway, Millikin University, and Dr. Brayton H. Ransom, of Washington, were elected to represent the American Microscopical Society in the council of the American Association for the Advancement of Science.

The business of prime importance was the determination of the future use of the Spencer-Tolles Fund for the encouragement of research, which now amounts to about \$3,500. The fund has been allowed to accumulate for a number of years without any productive use. It was agreed (1) that proper steps should be taken to safeguard the fund in case of the failure of the society; (2) to use the fund to encourage research within the society; (3) to begin the productive use of the fund at once, so that its memorial character may be realized.

More than one hundred new members and sub-

² Messrs. Alf Eastgate, of Tolna, and Elmer Judd, of Cando, N. D.

scribers have attached themselves to the society during the year, and 1912 gives promise of being the most successful and prosperous in the history of the society.

In the absence of the president, Dr. A. E. Hertzler, Professor C. E. Bessey presided over the meeting of the executive committee, and Professor M. J. Elrod over the business session.

T. W. GALLOWAY,

Secretary

THE SOUTHERN SOCIETY FOR PHILOSOPHY AND PSYCHOLOGY

THE seventh annual meeting of the Southern Society for Philosophy and Psychology was held at Washington, D. C., on Wednesday, Thursday and Friday, December 27, 28 and 29, 1911, in conjunction with the American Psychological Association and the American Association for the Advancement of Science. The meetings were held in the George Washington University Medical School, President Shepherd Ivory Franz presiding. The programs for December 27 and 28 were arranged jointly with the American Psychological Association. Following the joint meeting on Thursday afternoon came the president's address on "New Phrenology." On Thursday evening the members of both societies were entertained at a smoker held at the New Fredonia Hotel by Professors Franz and Ruediger.

The following items were passed upon at the business meeting held on Friday morning, December 29:

1. The proposed amendment to Art. II, Sec. 3, of the constitution was adopted.
2. It was resolved that the existing arrangement with the Psychological Review Publishing Company be continued as optional to the members of the Southern Society and be handled as hitherto by the secretary of the society. In the future, however, this option is available only to members residing in the southern territory, but it is no longer restricted to those who are new subscribers. Notice of the above arrangement is to be printed after the constitution on the membership list.
3. The secretary was authorized to drop the names of members after one year of delinquency.
4. The determination of the time and place of the next meeting was left in the hands of the council.
5. The treasurer's report was audited by the council and showed a balance on hand, December 23, 1911, of \$65.64.

6. The following officers were elected for the year 1912: *President*, Robert Morris Ogden, University of Tennessee; *vice-president*, H. J. Pearce, Brenau College, Gainesville, Ga.; *secretary-treasurer*, William Carl Ruediger, The George Washington University; *councilors*, Shepherd Ivory Franz, John Brodus Watson (for 3 years) and W. B. Lane (for 1 year).

7. The following persons were elected to membership: Samuel Claman, Howard University; H. E. Cunningham, Lookout Mountain, Tenn.; Gardner C. Basset, Johns Hopkins University; Williston S. Hough, George Washington University; Edmund B. Huey, Johns Hopkins University; Herbert Charles Sanborn, Vanderbilt University.

8. Votes of thanks were extended to Dean W. C. Borden for the use of the George Washington University Medical School and to Professors Franz and Ruediger for the smoker.

THE GEOLOGICAL SOCIETY OF AMERICA

THE twenty-fourth annual meeting of the Geological Society of America was held at the new National Museum at Washington, D. C., from Wednesday to Saturday, inclusive, of Christmas week, and was the largest in the history of the organization, there being a registered attendance of 140 fellows and 14 fellows-elect, besides many visitors. Professor William Morris Davis, president for the year, presided, having made a special trip for the purpose to America from Paris, where he is serving as Harvard exchange professor at the Sorbonne. The first session of the society was occupied with matters of business. The secretary reported the election of twenty-nine new fellows, making the present active membership of the society 351.

During the past year, there were lost by death Samuel Calvin, for many years state geologist of Iowa; Samuel F. Emmons, a noted mining engineer who was connected with the United States Geological Survey from its organization and was a member of the National Academy of Sciences; Christopher W. Hall, professor of geology at the University of Minnesota; Edwin E. Howell, of Washington, D. C., and Amos O. Osborn, of Waterville, N. Y. One foreign correspondent, Professor A. Michel-Lévy, a famous French geologist, died. An indication of the activity of the society was the publication during the year of a volume of its *Bulletin*, consisting of 738 pages of text and 31 plates, and including part of the papers read at

the last preceding annual meeting, which was held at Pittsburgh a year ago. A large part of the volume was devoted to E. O. Ulrich's contribution, "A Revision of the Paleozoic Systems."

In the course of the meeting the following papers were offered:

New Evidence on the Taconic Question: ARTHUR KEITH.

The reasons were given in this paper for reopening the old controversy and for selecting the north end of the Taconic Mountain as the crucial place. The principal views regarding the rocks of the Taconic Mountains were briefly outlined and the geology of the region summed up. Five subdivisions of the Stockbridge limestone around the north end of the Taconics were described and attention called to the extreme folding and metamorphism of the rocks. The slates of the mountains are sharply outlined from the Stockbridge limestone and the contact follows a rude semi-circle around the end of the mountains. The characters of this plane of separation were discussed and the conclusion reached that they can only be due to faulting. The bearing of this conclusion was briefly considered.

Some Features in the Grand Canyon of Colorado River: N. H. DARTON.

Several years ago, the author measured sections at a number of points along the Grand Canyon to determine the stratigraphy of the Arizona Plateau. These sections were presented, and there was exhibited a colored preliminary geologic map of the Vishnu, Bright Angel and Shinumo quadrangles similar to one now in the corridor of El Tovar hotel at Grand Canyon.

Covey Hill Revisited: J. W. SPENCER.

This remarkable hill terminates the northeastern point of the Adirondack plateau (1,030 feet above tide). It is capped with Potsdam sandstone thinly covered with drift. This hill is separated from the main plateau by a broad depression from which the drift has been swept away. Its removal is commonly attributed to the broad trough being a spill-way for a glacial lake. This question is not raised except that it may have belonged to an epoch before the Iroquois period. The broad trough is incised by a deep gorge—the Gulf. Its character has not been fully described. This heads in a small channel such as is being formed to-day, with the increase in size due to the undermining of the walls of jointed sandstone where the blocks are forced off by frost action. Thus the gorge can not be taken as evidence of a greater drainage

than at the present time. The gorge is post-Glacial for this reason, and does not represent the outflow from a glacial lake. A beach on the northern flank of the hill at 450 feet above tide has been supposed to be marine without the showing of any evidence. Upon revisiting the hill no evidence of the marine character was found.

Dr. Spencer's paper was discussed by J. B. Woodworth and H. L. Fairchild, and reply was made by the author.

• *Pre-Cambrian Formations in South-central British Columbia*: REGINALD A. DALY.

A reconnaissance along the Canadian Pacific Railway line has established the following conclusions: (1) Dawson's "Nisconlith series" occurring in the Selkirk Mountains is not Cambrian, but represents the northern continuation of the "Beltian" (Belt terrane) rocks at the International Boundary. (2) Dawson's "Nisconlith series" of the Shuswap Lakes area (west of the Selkirks) is an entirely different pre-Cambrian and pre-Beltian group of sediments, which unconformably underlie the "Nisconlith series" of the Selkirk section. (3) The Adams Lake volcanic series conformably overlies the thick limestones of the "Nisconlith series" in the Shuswap Lakes area and is of pre-Beltian age. (4) The "Shuswap series" of the Shuswap Lakes is not a distinct gneissic group unconformably underlying the "Nisconlith series," but is the facies of the "Nisconlith series" produced where that series was thermally metamorphosed by batholiths. (5) Though these pre-Cambrian rocks are typical crystalline schists, their metamorphism of the regional type was not due to dynamic action; it was "static" metamorphism (Belastungs-metamorphismus of Milch). (6) The pre-Cambrian rocks are much less deformed (upturned) than the overlying Carboniferous or Triassic rocks, illustrating the small depth of the earth-shell which underwent strong folding in post-Cambrian time. (7) The petrography of this pre-Cambrian and pre-Beltian terrane strongly suggests that it furnished the greater part of the elastic material of the Rocky Mountain geosynclinal prism.

Origin of the Sediments and Coloring Matter of the Eastern Oklahoma Red Beds: J. W. BEEDE.

Recent investigations seem to show that the sediments of the lower red beds of Oklahoma were derived from the Arbuckle-Wichita Permian land mass. The conclusion is based on the amount of material removed and the geographic distribution of sediments bordering the mountains. Coarse

limestone conglomerate of great thickness and conglomerates of crystalline rocks—both possibly of subaerial origin—dovetail into red beds. Belts of sandstone have been found extending into the area of finer sediments farther away from the mountains, apparently indicating the location stream debouchures at the margin of the shoal sea. The extreme shallowness of the water is clearly indicated in the structure of the beds. The coloring matter is thought to have been derived from the solution of the 8,000 or 10,000 feet of pre-Carboniferous limestone which formerly covered the Arbuckle-Wichita Mountains and much of the surrounding region. The solution of the limestone furnished optimum conditions for the oxidation of its iron content, as it does at the present time in the limestone regions of the Mississippi Valley, southern Europe, West Indies, etc. Moreover, the solution of the pre-Carboniferous limestones and the conglomerates of the Arbuckle-Wichita region now in progress produces a red residuum practically indistinguishable from red beds sediments. The red granites, red porphyries and other crystalline rocks of the region under discussion contributed their share of material to the red beds. Other factors may have entered largely into the formation of the red beds of western Oklahoma.

The paper was discussed by I. C. White.

Correlation of Rocks in the Isolated Coal Fields around the Southern End of the Rocky Mountains in New Mexico: WILLIS THOMAS LEE.

Several isolated coal fields in New Mexico, near the southern end of the Rocky Mountains, were visited, notably those near Cerrillos east of the Rio Grande and those on the Rio Puerco. Stratigraphic studies were made and fossil leaves and shells collected from the coal-bearing rocks and those stratigraphically near them, with two objects in view: first, of fixing the age of the coal beds, and second, of correlating the formations of the great coal fields on opposite sides of the mountains by means of the data from these small fields intervening between them.

Monument Creek Group and its Relations to the Denver and Arapahoe Formations: G. B. RICHARDSON.

The Monument Creek Group, Hayden's name for several thousand feet of arkosic deposits on the Platte-Arkansas divide in Colorado, is separated into two parts on the basis of a well-marked unconformity. The rocks above the break carry titanotherium bones of Oligocene age, and the rocks below contain leaves of Eocene age. The

lower parts of these lower deposits strike into the Arapahoe and Denver formations of the Denver Basin, and it appears that those formations are equivalent to part of the lower division of the "Monument Creek."

Dark Scale of Hardness: ALFRED C. LANE.

The hardness of a mineral is its resistance to shearing stress. Like other properties of minerals, it may differ in different directions. When two similar surfaces are rubbed together, the softer mineral leaves a powder (streak) on the other. In order to be sure which mineral gives the streak, it is at times convenient to have besides the common Mohs scale of hardness, composed of light minerals, a "dark scale of hardness" of minerals whose color and streak is dark, especially in teaching. For such minerals, the following properties are desirable: quickly recognizable, easily obtainable, hardness uniform. The following minerals have been used by the writer: (1) graphite, with 1 good cleavage, at one extreme in the white scale, at the other extreme in the black; (2) stibnite (Sb_2S_3), with 2 good cleavages, bladed; (3) galenite (PbS_2), with 3 good cleavages; (4) iron (use soft wire nail), magnetic, ductile; (5) niccolite (NiAs), characteristic color, no cleavage; (6) magnetite (Fe_3O_4), magnetic, brittle. The minerals mentioned seem fairly satisfactory. Above six, the author does not know whether spinel or some other mineral would be more desirable, but as there are comparatively few minerals concerned, it is not important.

Demonstration of Relative Refraction: ALFRED C. LANE.

The method of determining relative index of refraction developed by Exner, Becker and Schroeder van der Kolk¹ may be demonstrated to a class as follows: A large beaker of water placed just a little to one side of a window or other source of light will show a bright streak on the farther side, having a higher index than the surrounding medium. A test tube full of air placed in the beaker will show a bright streak of total reflection on the nearer side, the air within having a smaller index than the surrounding medium.

A Stratigraphic Study of the Appalachian and Central States with Reference to the Occurrence of Oil and Gas: GEO. H. ASHLEY.

It has always been supposed by the oil and gas men that the Appalachian region, extending from Pennsylvania to Alabama, was a stratigraphic

unit, and it has been a mystery that eastern Kentucky, Tennessee and Alabama should not yield as much oil and gas as Pennsylvania or West Virginia. The mystery largely disappears when a comparative study is made of the stratigraphy of the Appalachians as a whole. The paper compares graphically the stratigraphy of the southern and northern Appalachians and the central states with reference to the occurrence of oil and gas.

The paper was discussed by H. B. Kümmel.

Granularity Limits in Petrographic-microscopic Work: FRED E. WRIGHT.

In this paper the petrographic microscope is treated as a measuring device for the exact determination of the optical properties of crystal plates, especially of minute crystal fragments and of crystallites. The methods now available for the purpose are considered briefly with special reference to their accuracy and applicability to the investigation of fine-grained silicate preparations. Attention is directed in particular to the lower granularity limits at which satisfactory measurements of the different optical properties of a mineral grain can still be made.

The Arkansas Diamond-bearing Peridotite Area: L. C. GLENN.

Evidence will be offered of the circulation of presumably thermal waters about the margin of the original pipe described by Branner. A supposed extension of the peridotite area proves to consist of disintegrated peridotite mixed intimately with well-rounded quartz sand and occasional water-worn chert pebbles and was evidently water-laid. Indications of the age of this material will be given, narrowing down the period within which the extrusion of the peridotite must have occurred.

The paper was discussed by A. H. Purdue.

Resins in Paleozoic Coals: DAVID WHITE.

Resins are present in most coals, except possibly those of the highest grades, the amount depending in general on the degree of concentration (residual) resulting from the decay and reduction of the attending plant structures. Interesting examples of megascopic resins in coals from the Carboniferous of the Mississippi Valley and Montana indicate the presence of resin in the Paleozoic coals in proportions probably as large as in the coals of the Mesozoic and Tertiary.

Onyx Deposits in East Tennessee: C. H. GORDON.

The existence of onyx deposits in east Tennessee has been known for a long time, and attempts have been made at recurrent intervals to utilize the

¹ Report Michigan Geological Survey, Vol. VI, p. 154.

material. Thus far no success has attended these efforts, but with persistent frequency hopes are aroused over some new "find" and glowing announcements are made of the possibilities of this industry. The onyx found is of cave formation and for the most part represents the remnants of vanished caves. The character and extent of the deposits was discussed and the possibilities of their commercial development.

Variation of the Optic Angle of Gypsum with Temperature: EDWARD H. KRAUS.

By using an oil bath to determine the variation of the angle of the optic axes of gypsum at different temperatures it is found that gypsum is optically uniaxial at approximately 90° C. for sodium light. Although Mitscherlich observed in 1826 that this change takes place at about 92°, the values given later by Des Cloizeaux, and more recently by Tutton, both of whom used air baths, are from 15° to 26° too high. Nevertheless, Des Cloizeaux's value of 116° C. for red light is the one commonly quoted. By plotting the values of the apparent angles of the optic axes at various temperatures up to 132.5° C., it is easily seen that the angle changes most rapidly in the vicinity of the uniaxial point, that is, between 80° and 100°, and further, that one axis, as was pointed out by Naumann, changes its position more rapidly than the other.

Notes on the Paragenesis of the Zeolites: J. VOLNEY LEWIS.

Zeolites and other secondary minerals occur in the Newark igneous rocks of New Jersey: (1) in cavernous spaces in the ropy pahoehoe of the extrusive Watchung basalts; (2) in fault fissures and fault-breccia of both the basalts and the great intrusive sill (Palisades, Rocky Hill and Sourland Mountain); (3) less commonly in the ordinary joint cracks of both the extrusive and the intrusive types. The rocks are essentially the same in both chemical and mineral composition, consisting essentially of pyroxene and plagioclase feldspars, with quartz-bearing and olivine-bearing facies. The zeolites and related silicates are essentially combinations of the feldspathic elements and water, with the addition of fluorine in apophyllite and boron in datolite; the accompanying amphibole, biotite, chlorite, epidote, serpentine and talc are derivatives of the pyroxenes. Hypotheses of origin dependent on the action of meteoric waters are inapplicable on account of difficulties of circulation, deoxygenation and sources of fluorine and boron; on the other hand, contact metamorphism

by the intrusives has produced in the adjacent shales minerals into which fluorine and boron enter, presumably by emanation from the magma. Hence magmatic waters are regarded as the most probable agent in the formation of the zeolites and accompanying minerals.

The paper was discussed by A. C. Lane and F. R. Van Horn.

Peculiar Iron Ore from the Dunham Mine, Pennsylvania: W. S. BAYLEY.

No abstract received.

Glacial Deposits of the Continental Type in Alaska: R. S. TARR and LAWRENCE MARTIN.

The glaciation of the interior of Alaska forms a striking contrast with the coast, where glacial erosion forms predominate, the deposits being largely under water, except for (1) 1,600 square miles east of Yakutat Bay, (2) 16,000 square miles in the Cook Inlet-Susitna Valley region, and smaller areas. The interior, between the coast ranges and the Endicott-Rocky Mountain system, where the National Geographic Society's party made some studies in 1911, has extensive glacial deposits of the continental type, previously described in part by Russell, Brooks and others and similar to those of the United States. These include at least (a) 15,000 square miles in the Copper River basin, (b) 27,000 square miles in the Tanana and Kuskokwim valleys, (c) 17,000 square miles in the Yukon Flats, (d) several thousand square miles on the Upper Yukon region in Canada and smaller areas. The dominant material is outwash and this extends long distances outside the country actually glaciated. In places there is wind-blown loess associated with this. In some localities it is still being deposited, and in the Copper River basin it has been accumulating during the time required for the growth of six or seven generations of trees. There is also some till, but this is largely buried beneath outwash. Lake deposits, eskers, kames and buried vegetation are also found, but thus far no one has found drumlins. In thickness, some of these deposits rival those of the middle west, one instance being known of probably 800 feet of gravel, sand, etc., grading out from the mountains to less than 100 feet fifty miles away. The presence or absence of these drift deposits seems to be chiefly a matter of favorable topography and existing deglaciation, a process much like that formerly in progress in northeastern and central United States.

The paper was discussed by W. M. Davis, C. A. Davis and H. M. Eakin.

Glaciation in Northwestern Alaska: PHILIP S. SMITH.

In northwestern Alaska there are small existing glaciers and evidence of much greater alpine glaciers in the geologic past. The present communication aims to set forth some of the observations made by parties from the U. S. Geological Survey during the field season of 1910 and 1911 in the Kobuk and Noatak regions of northwestern Alaska, which bear on the glacial phenomena.

Pre-Wisconsin Glacial Drift in the Region of Glacier Park, Montana: WM. C. ALDEN.

Along the east front of the Rocky Mountains from Two Medicine Lake northward to the International Boundary, valleys of most of the streams issuing from the mountains are bordered on either side by high, flat-topped ridges, whose crests stand 800 to 1,600 feet above the adjacent valley bottoms with maximum elevations ranging from 5,800 to 6,400 feet above sea level. These high flat-topped ridges taken together have the appearance of being remnants of a continuous high-level plain bordering the base of the bold mountain front and they have been so interpreted by Salisbury, Calhoun, Willis and Finley. Examination of nine of these ridges, those adjacent to Two Medicine, Cut Bank, Boulder, Swift Current and Kennedy creeks, and St. Marys and Belly rivers, and of high benches at corresponding levels on the west side of Belly River, shows the massive ridges to be composed of Cretaceous shales and sandstones with a capping of glacial drift ranging in thickness from 100 to several hundred feet. Fresh scarps resulting from recent slumping afford excellent exposures of the typical glacial till containing abundant striated boulders. In several places much of the till is cemented to a hard tillite conglomerate. In some places, as in the type exposure of Willis's "Kennedy gravels," the material is coarse, sub-angular to rounded cobble-stone gravel composed principally of quartzite, but even here careful search yielded numerous striated pebbles. Striated pebbles and boulders were found on the extensive flat top of Milk River Ridge eight miles from the mountain front. The component material in all cases is derived from the mountains. During the last great epoch of glaciation, the glaciers extended down nearly all the intervening valleys, in some cases nearly filling them. Cut Bank Glacier spilled through sags in the crest of Milk River Ridge, and St. Marys' Glacier laid its lateral moraine along the upper slope and lower part of

the crest of St. Marys Ridge, but in some places the high level drift rises above that of these valley glaciers and is quite distinct therefrom, though of similar lithological composition. The topographic relations, cementation and considerable amount of modification due to weathering indicate that the high level drift is much older than that in the valleys, and represents a distinct and earlier stage of glaciation separated from the Wisconsin by a long interval during which much erosion was accomplished. Although the relations have not yet been carefully studied, it appears that this older drift includes some at least of the "quartzite gravels" described by the authors cited above, and regarded as pre-Glacial and possibly, but not certainly, some of those described by Dawson and McConnell in southern Alberta and denominated "Albertian Drift."

The paper was discussed by W. W. Atwood and A. P. Coleman.

Some Glacial Deposits East of Cody, Wyoming, and their Relation to the Pleistocene Erosional History of the Rocky Mountain Region: WM. J. SINCLAIR.

Twelve miles east of Cody, Wyoming, in the Eocene badlands in the vicinity of McCulloch Peak, angular blocks of Paleozoic limestone occur at elevations of 6,000 feet above sea, either on the crests of narrow ridges separating deep valleys cut in the badland clays or on terraces several hundred feet above the Shoshone River. No other rocks than limestone have been seen in these high level deposits, but at lower levels abundant pebbles and boulders of andesite may be found, all of which are water worn, while the high level material is highly angular, the only sign of abrasion being the pitted surface produced by the solvent action of rain water. Corals and bryozoa frequently appear in relief on the rain-etched surfaces. Individual fragments vary in size from a few inches or less to blocks $6 \times 8 \times 4$ or 5 feet. The source of the limestone is, undoubtedly, the Paleozoic formations of the mountains to the west of Cody. Glacial ice is the only known agent capable of transporting blocks of the size indicated. If they have been transported by ice, 1,200 feet or more of canyon cutting has intervened since their deposition, for they are stranded on narrow divides and comb ridges at least that high above the Shoshone River. If they are to be correlated with the first glacial advance in the Rocky Mountain region, much of the deep dissection of such intermontane troughs as the Bighorn Basin

must be regarded as an event of Pleistocene time.

The paper was discussed by W. W. Atwood and Wm. M. Davis.

Fossils of Lower Limestone of the Steep Rock Series: C. D. WALCOTT.

The paper described a new genus and two species of sponges found by Dr. A. C. Lawson in the limestone of the Steep Rock Series of Canada.

The paper was discussed by A. P. Coleman.

Evidence of Three Distinct Glacial Epochs in the San Juan Mountains of Colorado: WALLACE W. ATWOOD and KIRTLEY F. MATHER.

Abundant evidence of two distinct Glacial epochs has been reported by several investigators from various mountain ranges in the western portion of the continent. During the past season glacial deposits have been examined and mapped about the margin of the San Juan Mountains, which deposits have been interpreted to indicate an epoch of glaciation distinct from the two later epochs that have been clearly recognized in the history of the range.

For convenience, the three distinct epochs are referred to, beginning with the oldest as "San Juan," "Big Horn" and "Uinta."

The composition, distribution and topographic relations of the San Juan glacial drift indicate that this earliest known epoch was separated from the Big Horn Glacial epoch by a much longer time than the Big Horn was separated from the Uinta. The two later epochs appear to have been separated by a much longer time than has elapsed since the last disappearance of glacial ice from the range. The San Juan Glacial epoch is so far removed from the present time that the glacial deposits of that epoch are found at but a few places, where conditions were most favorable for their preservation.

There are reasons for believing that the San Juan Glacial epoch may have been characterized by small ice caps among the western ranges rather than by Alpine glaciers, which were the prevailing type during the Big Horn and Uinta epochs.

There are good reasons for believing that the San Juan epoch preceded the development of the great canyons among the mountains, and, therefore, that much of the sculpturing which has given form to the scenic features of the range is inter- and post-Glacial in origin. The time relation of the epochs of glaciation to other events in the physiographic history of the range were also suggested.

The paper was discussed by H. E. Gregory.

Glacial Investigations in Minnesota in 1911:

FRANK LEVERETT.

A sheet of old calcareous drift deposited by an ice sheet radiating from central Canada covers nearly all of Minnesota and extends into western Wisconsin. The prominent moraines of western Minnesota, named by Upham, Itasca, Leaf Hills and Fergus Falls, were formed in the order named, as is shown by the glacial drainage from them. The rock constituents of these moraines show remarkable disintegration that suggests a possible pre-Wisconsin age. After these moraines were formed by the ice radiating from central Canada, there followed an ice movement radiating from the high tableland northeast of Rainy Lake. This moved across the northern ends of the above-named moraines and extended a few miles beyond the portion of the Mississippi above St. Paul. This produced the so-called "red drift." After this ice movement waned there followed a readvance of the ice sheet radiating from central Canada which had its main axial movement through the Red-Minnesota-Des Moines Valley; but which also extended southeastward across the portion of the Mesabi Range west from Hibbing, Minnesota, and spread to the left and right in a basin which divides its drainage between the St. Louis and Mississippi Rivers. This ice movement deposited the so-called "gray drift" of the Minnesota Reports. It forms only a thin veneer on the portions of the Leaf Hills and Fergus Falls moraines which it overrode, and it failed to cover all of the Leaf Hills moraine. The correlative position of the Lake Superior Lobe is found to have been but little beyond the western end of the present lake, in Carleton County, Minnesota. A large glacial drainage line opened a great valley along the St. Louis between Floodwood and Carleton, but was there turned southwestward because of the presence of the Superior Lobe. The relations of this latest ice movement from central Canada to the Glacial Lake Agassiz are such as to make necessary a radically different interpretation from that given by Upham in his monograph on Lake Agassiz.

The paper was discussed by Lawrence Martin and J. B. Tyrrell.

Recent Studies of the Moraines of Ontario and Western New York: FRANK B. TAYLOR.

The paper was entirely descriptive of moraines recently mapped in the areas of Ontario and western New York.

Remarks were made by W. M. Davis and H. L. Fairchild.

A Grooved and Striated Contact Plane between the Nebraskan and Kansan Drifts: J. ERNEST CARMAN. (Introduced by George F. Kay.)

The paper described the unique feature of a grooved and striated contact plane between the Nebraskan (pre-Kansan) and Kansan drifts. Both sides of the contact plane are striated. Neither side is the mold of the other. The possible explanations are considered and the conclusion reached that glaciation produced the feature.

The Nebraskan Drift of the Little Sioux Valley in Northwest Iowa: J. ERNEST CARMAN. (Introduced by George F. Kay.)

The paper traced a farther extension of the Nebraskan drift and compared the Nebraskan and Aftonian deposits of this region with those along the Missouri River.

Dr. Carman's two papers were discussed by J. W. Spencer, F. Leverett and W. M. Davis.

Hanging Valleys and their pre-Glacial Equivalents in New York: J. W. SPENCER.

Visiting that most beautiful gorge, Watkins Glen, at the head of Seneca Lake, it would seem that the stream is entirely post-Glacial; but above the railway bridge a great cove, like that of the Whirlpool Basin at Niagara, is developed, with its northern side and end composed of drift. Its continuing channel to the lake has been discovered by boring. The same is true of other falls in this locality. Taughannock, on the western side of Cayuga Lake, is of little less importance. Its pre-Glacial channel, as observed by Hall in 1842, is situated immediately to the north.

Equally important are hanging valleys in northern New York. Between Carthage and Boonville is a plateau at 1,400 feet above sea level, overlooking the Black River and the much lower country east of it. The plain is bounded on the west by an escarpment 500 feet high, surmounted by another plateau. The Black River shales here are easily incised. Here the finest hanging valley with waterfalls is Whetstone Gulf, two miles north of Housie P. O., while the great pre-Glacial valley occurs at this hamlet, with the drift partly removed from it.

It seems that wherever an important drainage basin occurs with modern waterfalls, equivalent pre-Glacial valleys may be found, although more or less filled with drift. Accordingly, in New York State hanging valleys of themselves are no evidence whatsoever of the over-deepening of the trunk valleys or plains in front of them by glacial erosion.

Closing Phase of Glaciation in New York: H. L. FAIRCHILD.

As the Labradorian ice sheet melted away from the north border of New York State, it allowed the water of the ice-bound Lake Iroquois to escape at Covey Hill Gulf and to pass around the northeast slope of the Adirondack highland. Being confined and directed by the ice border, this stream flow produced the extensive areas of bare rock in the towns of Mooers, Altona and Beekmantown, formerly described by Woodworth (N. Y. State Museum Bulls., 83, 84). The later stream flow, along the Altona rocks, determined the level of a narrow lake lying northwestward, into which Lake Iroquois was lowered by the waning of the ice front on Covey Hill, and for a time this lake succeeded Iroquois in the Ontario basin. It is proposed to call this water Lake Emmons (after Ebenezer Emmons, whose district in the first geologic survey of the state covered this area). The further weakening of the ice border finally allowed Lake Vermont (named by Woodworth), which had previously been confined to the Champlain Valley, to succeed Lake Emmons and in turn to occupy the Ontario basin. It is proposed to call this expanded water Lake Vermont-New York. These two water planes in the Ontario basin, inferior to Iroquois, are represented chiefly by delta sand-plains on the larger streams. Eventually the waning of the ice east of the Champlain embayment allowed the glacial waters to become confluent with the sea, and the sea level waters were thus established in both the Champlain and Ontario basins at the same time. The height of the marine beaches about Covey Hill is 525 feet, which definitely gives the amount of land uplift on the international boundary since the ocean transgressed that area. Maps exhibit the glacial drainage channels, the deltas and the shore lines of the three water planes in the Champlain district and the four planes in the Ontario district.

The paper was discussed by F. B. Taylor, J. W. Spencer and H. L. Fairchild.

Post-Glacial Erosion and Oxidation: GEORGE FREDERICK WRIGHT.

(1) Opportunities for observation in Ohio. (2) Small amount of erosion by the streams north of the watershed entering Lake Erie. (3) Esker terraces in the valleys of the Styx and Killbuck on the south side of the watershed. (4) Comparison of calculations from these sources with those from Niagara and other post-Glacial gorges. (5) Ex-

tent of pre-Glacial oxidation. (6) Evidence of small amount of oxidation since the Wisconsin epoch. (7) Evidence that the till of the earlier Glacial epoch consists largely of material oxidized during pre-Glacial times. (8) Evidence of unoxidized material mingled with the highly oxidized material of the earlier epoch. (9) Evidence indicates that the date of the Wisconsin epoch is to be reckoned by thousands, rather than by tens of thousands of years, and the earlier epochs by tens of thousands rather than by hundreds of thousands of years.

The paper was discussed by F. Leverett, J. W. Spencer, H. L. Fairchild and the author.

The Intermingling of Pleistocene Formations: B. SHIMEK.

The paper discussed the effect produced by ice-sheets passing over older Pleistocene formations. Special illustrations are found in the mingling of fossiliferous loess and Wisconsin drift at Des Moines, Iowa, fossiliferous silts at Sioux Falls, S. D., and in other places.

Loess a Lithological Term: B. SHIMEK.

The term "loess" has commonly been understood as implying a more or less distinct division of time. The fact is set forth that there are several loesses deposited at different periods and that loess does not designate a distinct period of time, but indicates rather a condition of deposition, as do such terms as "sandstone," "limestone" and "drift."

Professor Shimek's two papers were discussed by W. C. Alden, F. V. Emerson, Frank Leverett, G. F. Wright and the author.

Criteria for the Recognition of Ancient Delta Deposits: JOSEPH BARRELL.

Previous to the discussion of criteria, definitions were given and an analysis of the parts of a delta. The criteria naturally are different for each part. Variations in the proportions of the parts, the ratios in which these may enter into ancient formations and the intergradations of parts were next considered. Where the conditions of delta growth were such as to give gradations between parts, the criteria become overlapped and tend to result in confusion. It is concluded that deltas of previous geologic ages have commonly developed under quite different conditions from those taken as typical in modern deltas. The principle of a delta cycle is next developed, showing the theoretic stages of rivers building outward and upward against the sea, followed in a later stage by marine dominance

and plantation. Where the larger features of an ancient deposit are known, the principle of the delta cycle may be of value as a criterion of origin. Illustration is made by application to the late Mesozoic formations of the Atlantic Coastal Plain. The evaluation of stratigraphic criteria is next taken up with the view first of separating the sub-aerial delta beds—those periodically exposed to the air, from the subaqueous—those permanently covered with water. Secondly, however, the criteria record also physiographic and climatic conditions controlling the character of the beds. The stratigraphic criteria are taken up in order, and the degree of significance attaching to each is discussed. Two chief conclusions are reached. First, the need of extended study of the stratigraphic characters of present sedimentation. Second, most individual criteria are to some degree indeterminate and a conclusion in regard to the mode of origin of a formation or part of a formation should, in order to obtain acceptance, be based on the convergence of several lines of evidence.

Stratigraphic and Paleontologic Features of Ancient Delta Deposits: A. W. GRABAU.

After a brief reference to the pre-Cambrian or early Cambrian delta fan of the Pacific Province and the Torridon of Scotland, the author discussed the late Ordovician and early Silurian fans of the Appalachian region, the Schawangunk dry delta fan and its relationship to the Salina desert, the Esopus delta and its relation to the Oriskany deposits, the Early Devonian talus breccia of Michigan and western Ontario, the Old Red of Scotland and the Catskill group, the Pocono, Mauch Chunk and Pottsville and the Triassic fans of America and western Europe, with special reference to their stratigraphic and paleontologic characters and their bearing on paleogeography.

A Mississippian Delta in the Northern New River District of Virginia: E. B. BRANSON.

A delta started in the Devonian in the New River district and continued through most of the Mississippian. The thickness of the Mississippian part is more than 5,000 feet and consists of varicolored shales and sandstones that thin out in all directions excepting southeast from this region. The Mississippian rocks are known as the Pulaski formation and are to be correlated with the Pulaski, Greenbrier, Bluefield and Hinton formations fifteen miles farther north.

Discussion of the last three papers was participated in by J. M. Clarke, David White, G. W.

Stose, A. Keith, G. I. Adams, E. T. Wherry, H. B. Kümmel and W. C. Alden, with replies by Joseph Barrell and A. W. Grabau.

Differential Erosion and Equiplanation in Portions of Yukon and Alaska: DELORNE D. CAIRNES. (Introduced by Percy E. Raymond.)

Certain limestones and dolomites have been found to offer much greater resistance to ordinary sub-aerial erosive agencies than most other types of sediments, although many of these may be considerably harder and apparently better adapted to withstand the destructive forces to which rocks are exposed. In portions of the Yukon plateau province, the original peneplanated upland surface has been almost entirely destroyed in areas in which the bed rock is chiefly highly metamorphosed slate and quartzite, but is well preserved in adjoining tracts where limestones and dolomites predominate.

Where remnants of the original plateau-surface remain, agencies, including nivation, frost and chemical action are at work on the upland tending to remove all inequalities of the surface by transporting material from the upper to the adjoining lower levels; for this process the term "equiplanation" is proposed. This name has suggested itself as its results tend to make the elevation of all points equal in the area affected. Equiplanation is the reverse of peneplanation, as by isoplanation there is but a slight if any loss of material within the planated areas, but in peneplanated tracts all crustal matter above sea-level tends to become transported to the ocean. Equiplanation thus includes all planating activities, even wind action, whereby a plain-like surface tends to be produced, and by which there is no perceptible loss of material to the planated tract; all ordinary stream action, which is the main factor in peneplanation, is thus excluded.

The paper was discussed by W. W. Atwood, W. M. Davis, H. M. Eakin and the author.

The Cenozoic History of the Wind River Mountains, Wyoming: L. G. WESTGATE and E. B. BRANSON.

A preliminary account of the successive peneplanes, partial peneplanes and terraces of the southern part of the Wind River Mountains, the pre-Glacial gravels capping some of the terraces and the relation of the terraces to deposits of an earlier and a later glaciation.

The Stability of the Atlantic Coast: DOUGLAS WILSON JOHNSON.

The results of the Shaler Memorial investigation of shoreline changes along the Atlantic coast

indicate that there has been no appreciable subsidence of this coast within the last few thousand years. The phenomena which seem to indicate recent subsidence appear to fall into three groups:

(1) Fictitious appearances of subsidence which are produced by wave action on a retrograding shore line without any change in the level of land or sea; to this group belong many instances of submerged stumps, peat exposed at low water on the seaward side of barrier beaches, erect trees recently killed by the invasion of salt water, etc. (2) Phenomena produced by a local rise in the high tide surface, due to a local change in the form of the shoreline, unaccompanied by any general change in the relative level of land and sea; in this group may be found examples of practically all phenomena ordinarily attributed to a recent subsidence of the land. (3) Phenomena produced by an actual subsidence of the land or rise of the sea level which occurred some thousands of years ago; in this group belong many of the deeply buried peat deposits and submerged stumps. The evidence of coastal stability consists of (1) the form and position of successive beach ridges the oldest of which were built by the waves thousands of years ago, yet later than the deeply buried peat deposits; (2) the position of abandoned marine cliffs on which the waves can not have worked in recent time; and (3) the absence of a fringe of dead trees on those portions of the coast which are exposed neither to direct wave attack nor to local fluctuations of the high tide surface. It is concluded, with reference to the Atlantic coast, that the land can not have subsided as much as a foot within the last century; that there can have been no long-continued progressive subsidence at so high a rate as one foot per century, within the last few thousand years; and that no evidence thus far available can be regarded as satisfactory proof of any degree of recent subsidence, either spasmodic or progressive.

The paper was discussed by C. A. Davis, H. B. Kümmel, J. W. Spencer and A. C. Lane.

Physiography of the East African Plateau: GEORGE L. COLLIE.

Four physiographic regions may be recognized in British East Africa. First, the coastal plain; second, the foot plateau; third, the gneiss plateau; fourth, the lava plateau, which includes within its boundaries the great Rift Valley. The coastal plain is generally but two or three miles wide. It is composed of recent coral rock, and it is a true degradation plain; the agent is probably marine

erosion. Rising rather abruptly from the coastal plain is the great plateau which extends to the basin of Victoria Nyanza. The frontal portion, called by Gregory the foot plateau, is underlain by sedimentaries of Mesozoic age. The main portion of the plateau is gneiss, but toward its western border there have been great extravasations of lava, which have completely covered the original gneiss surfaces over a belt 100 miles wide and extending north and south indefinitely. The lava flows are connected with the rifting processes that have formed the rift valley. The underlying rocks have some bearing upon the minor features of the different regions, but this is a matter of detail. The plateau as a whole from ocean to the Victoria Nyanza basin should be considered as a unit in its larger aspects. The plateau is a very ancient feature; it has been thoroughly peneplaned, though great residual masses of gneiss remain, especially in the region between Voi and Kiu. These mound rocks in some cases rise to the dignity of mountain ranges. The most remarkable feature of the plateau is the constant, uniform rise of the peneplaned surface from sea level to a height of nearly 10,000 feet at the Man or western escarpment of the Rift Valley. The plateau surface is really a great beveled slope which rises on the average about 20 feet to the mile for 500 miles. The plateau is typical of those that lie in the monsoon region, in that only the higher portions and those that lie near sea level are being acted upon by normal erosion. The intermediate and by far the greater area is being degraded by deflation and sheet-flood erosion, chiefly. There are two brief and widely separated rainy seasons. The conditions are such that, in the main, there is a large intake of ground water and relatively little run off, and hence very little dissection. In the interim between rainy seasons the ground becomes parched and dry, so that deflation becomes of importance and offsets dissection. The plateau confirms the truth of observations made in South Africa and elsewhere that one type of peneplanation may go on at any altitude above sea level. This type of peneplanation does not require desert conditions, as is sometimes said. Thirty inches of water fall annually over much of this plateau, but it does not require monsoon conditions where rainfall is concentrated in widely separated rainy seasons with arid or semi-arid conditions in between.

On the Nomenclature of Faults: HARRY FIELDING REID.

This was a preliminary report by the chairman of the committee appointed by the society at the Baltimore meeting (1908) and was submitted for discussion and criticism in advance of making a final report at the next meeting of the society.

Boulder Beds of the Caney Shale at Talahina, Oklahoma: J. B. WOODWORTH.

The Caney shales of Mississippian age in southeastern Oklahoma carry grooved and striated stones and large boulders, all of which phenomena have been described by Mr. J. A. Taff, of the Geological Survey. The writer describes the best known locality near Talahina, Okla., and ascribes the markings on the stones and boulders to internal rock movements accompanying the faulting of the beds. It is thought with Mr. Taff that the distribution of the boulders, aside from the nature of their striated surfaces, demands transportation by ice. Other evidence is briefly cited in support of the idea that the Permian Glacial period was preceded by signs of widely distributed ice action of one kind or another in the Carboniferous period in the northern hemisphere.

Some Coastal Marshes South of Cape Cod: CHARLES A. DAVIS.

A report on a continuation of the work on salt marshes in the vicinity of Boston, the results of which were reported at the Boston meeting of 1909. The structure of salt and brackish marshes on the south side of Cape Cod and on Long Island was described and the bearing of this on the problem of recent coastal subsidence was discussed.

The paper was discussed by J. B. Woodworth, A. W. Grabau and the author.

Structure of the Helderberg Front: A. W. GRABAU.

The Helderberg Front is the northern extension of the westernmost belt of the Appalachian folded area, left after extensive erosion. The former extent east of the Hudson is partly indicated by Becraft Mountain and Mt. Ida. The basal part is of folded Hudson strata unconformably succeeded by late Silurian showing various phases of overlap. The Appalachian folds are of the usual asymmetric type, while the range from near Rosendale to Catskill and beyond is complicated by one or more pronounced overthrusts. The first of these was described by the author from Kingston and subsequently more fully discussed by Van Ingen and Clark. Chadwick has described a part of the thrust at Saugerties, and the author has determined its character near Catskill. Several new sections from this last region were presented.

The paper was discussed by J. B. Woodworth.

Some Relations between Gravity Anomalies and the Geologic Formation in the United States: WILLIAM BOWIE. (Introduced by A. H. Brooks.)

A report of an investigation of topography and its isostatic compensation upon the intensity of gravity will soon appear as a Coast and Geodetic publication. This and a subsequent investigation, involving 124 gravity stations, show the gravity anomalies in the United States are very small as a rule and that there is no apparent relation between the size and sign of the anomalies and the character of the topography. There is, however, a relation between the sign of the anomalies and the geologic formation. The stations in the older formations tend to have anomalies of the positive sign, indicating an excess of mass, and the stations in the most recent formations tend to have anomalies with the negative sign. It is probable that the anomalies are caused by erroneous assumptions regarding the surface density of the material at a station, and to a departure of the crust of the earth near the station from a state of complete isostatic compensation.

The paper was discussed by H. F. Reid and the author.

The following papers were presented by title:

Geological Reconnaissance in Northeastern Nicaragua: OSCAR H. HERSHEY.

The Geology of Steep Rock Lake: ANDREW C. LAWSON.

The Mesozoic Stratigraphy of Alaska: G. C. MARTIN.

Color Scheme for Crystal Models: GEORGE H. CHADWICK.

Occurrence of Petroleum Associated with Faults and Dikes: FREDERICK G. CLAPP.

New Minerals from the Favas of Brazil: OLIVER C. FARRINGTON.

Progress of Opinion as to the Origin of the Iron Ores of the Lake Superior Region: N. H. WINCHELL.

Saponite, Thalite, Greenalite and Greenstone: N. H. WINCHELL.

Pre-Wisconsin Channels in Southeastern South Dakota and Northeastern Nebraska: J. E. TODD.

Geographic Cycle in an Arid Climate: Should its Development be by Wind or Water? CHARLES R. KEYES.

The Effect of Rapid Off-shore Deepening on Lake Shore Deposits: RUFUS MATHER BAGG, JR.

List of Underground Temperatures in the United States: N. H. DARTON.

A Bibliography of the Mammoth Cave: HORACE C. HOVEY and R. ELLSWORTH CALL.

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Wednesday evening the Geological Society of America joined with other affiliated societies and the general American Association for the Advancement of Science in listening to the address of welcome by President Taft. Thursday afternoon was devoted to visiting the Geophysical Laboratory of the Carnegie Institution, while the evening was occupied with the annual dinner of the society followed by much speech making under the leadership of Dr. J. M. Clarke, of Albany, N. Y. On Friday evening, the presidential address of Professor Davis was followed by a smoker at the Cosmos Club tendered by the Geological Society of Washington to the Geological Society of America, the Paleontological Society and the Association of American Geographers.

The next meeting of the society will be held at Yale University, New Haven, Conn., a year hence.

EDMUND OTIS HOVEY,
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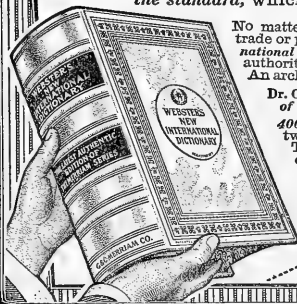
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NEW PHRENOLOGY¹

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A HUNDRED years ago, when Gall and Spurzheim published the results of their work, the anatomy of the brain was poorly understood, and the explanations of the relation of its parts, or of the relation of the brain as a whole, to mental states and processes, were interwoven with absurd fancies or with quibbling speculations. There were many guesses postulating definite functions for large areas or divisions of the brain. The assumptions and suppositions were combated and defended mainly by logical methods, and, because of religious and other *a priori* views, direct observation and experimental methods took a subordinate position. What was lacking to make one or another of the various views acceptable was a series or collection of vitalizing facts that could be utilized or adduced in its support. The importance of the cerebellum was magnified by some; it was believed to be the seat of memory, or that of the so-called higher intellectual faculties. The basal ganglia were also thought by others to be concerned with the intellectual processes, whether as the structures or storehouses in which memories were collected or as the element involved in the processes of thought. Even the ventricles had been suspected of being the seat of certain intellectual functions, although it is probable that this view had no direct adherents at the time Gall began his investigations.

The foundation for Gall's work and teaching has been laid by Reil and others

¹ Address by the president of the Southern Society for Philosophy and Psychology, Washington, December 28, 1911.

who had previously taught the supremacy of the brain itself, and who had regretted the lack of knowledge of the anatomy of this important viscus. In support of their views, a few observations could be cited of patients who had lost particular functions, such as sensations, or the ability to move or to speak, when the brain was injured. The associations of these losses with brain injuries had rightly led some to believe that the brain is an organ with diversified functions. Many of the adherents to this view held, however, "that one can not explain the loss of certain intellectual faculties in certain cases except by admitting that the brain is composed of many partial organs," and also that "the smallest parts of the brain have special functions."

Gall, as he remarks in the preface to the work on the "Anatomy and Physiology of the Nervous System," had made numerous observations of the relation of facial, cranial and mental characteristics, and the hypothesis of diversified functions for different brain areas well fitted his own views. This was the origin of physiognomy and of phrenology. The mind, it was supposed, is composed of a collection of units, of mental states or faculties which differ from one another in degree or in kind. It was presumed, therefore, that some localized part of the brain was concerned with each of these supposedly different states and processes, and, consequently, it was believed that it should be possible to find definite brain centers which are associated with, or which produce by their activity, different mental processes. Thus was born a definite conception of centers in the brain for particular mental acts. This conception was naïve and crude, to be sure, but it is the one which has dominated neurology and nervous physiology for the past century,

and which is still to be recognized in present-day teaching and writing.

This view led to various attacks and defences, bombardments and counter attacks, which were usually futile in advancing the knowledge of the relations which were discussed but which were indirectly of the greatest value in the advance toward a better understanding of the relation of clinical phenomena to brain lesions. The discussions led to observations and to careful comparisons of material so that the doctrine of exact localization of centers was not new at the time that Broca startled the neurological world with the report of the relation of a definite brain lesion with the loss of the ability to speak.

The rigid localizations of Gall and the vagaries of Spurzheim and his imitators were not received with entire confidence and faith, but the conception of one function for one part of the brain was too simple and too alluring to be dispensed with. Instead of the general formula that the brain is the organ of mind, divisions were introduced and both the brain and the mind were fractioned. Observations of other aphasic conditions with concomitant cerebral lesions were recorded and the strict localization view continued to be dominant. Wernicke and his disciples stood on the platform with Gall, and discussed learnedly of concept and percept centers and centers for motor images in the cerebral cortex. It was supposed that the recently announced discovery of Fritsch and Hitzig afforded evidence of this for the motor sphere and the precise localization in the cortex of definite centers for sensory processes by various physiologists made many certain that the hypotheses underlying phrenology were correct. All were compelled to admit the principle of cortical cerebral localization, but the meaning of localization proved to be an apple

of discord (*e. g.*, the discussions between Munk, Goltz, *et al.*).

There were some who disputed the functional dismemberment of the brain, and withstood the establishment of spatial localizations for definite mental functions, but their voices were not listened to or their facts were denied, or their arguments disregarded. They contended that the clinical and physiological facts gave no warrant for a localization in parts of the cerebral cortex of mental functions as such, and furthermore they pointed out that the cortical centers did not operate independently, and that functions could not be considered apart from the totality of the elements involved.

The schematism of phrenology was, however, too alluring; it gave a definiteness to diagnosis, and it satisfied certain other practical and theoretical desires. Criticisms of this view from the psychological standpoint were laid aside, but since many of the clinical facts could not be fitted to the anatomical divisions, other evidence was sought. The myelogenetic studies of Flechsig were hailed as witnesses to support the contention of the anatomical localizations of mental processes. The developmental differences of Flechsig's fields (now forty in number) of the cerebral cortex were received with gladness, and were used as additional splints and crutches for the doctrine. But even this was not sufficient. Anatomical localization of the mental faculties could not be made certain without additional support and it is within the past few years that our latest contributions to the doctrine of phrenology have appeared. These may be described in brief as the histological localizations of mental processes.

It was discovered that certain areas of the cerebrum differ both macroscopically and microscopically from other areas, and

the careful examinations of the cerebrum led to the division of the cortex into a number of areas, which were considered by the observers to be quite distinct from one another.

Elliott Smith made a careful examination of the naked eye appearances of all regions of the cerebral cortex and found that the streaks of light and shade differed in parts. The conclusion was drawn that these appearances indicated differences in the arrangement of cells or fibers in the cortex and that the cerebral cortex could, consequently, be divided into these anatomically distinct areas. Campbell and Brodmann used finer methods, those of histology, and discovered that the cerebral cortex could be divided into areas, which had the cells collected in different groups, or which had different sizes of cells, or which had the fibers arranged in characteristic ways. Depending upon the methods which are used, the number of these histologically and macroscopically distinct areas varies from about eighteen to fifty. It does not appear to make much difference that the histologists are not in accord in regard to the number of the histologically distinct areas, or in their exact individual location, the important point appears to be that certain areas are anatomically distinct, sufficiently so, that they may be recognized by their histological and gross appearances.

These areas, because of their differences in structure, are supposed to have different functions. Brodmann has given the clearest pronouncement regarding the supposed functional value of these observations. He has written: "physiologically unlike parts have unlike structure," and "parts of organs which differ structurally must have different functions."

In these statements we have the entering wedge for a more complete phrenology than has been advocated since the time of

Gall. If each of these areas, histologically distinct from one another, has an individual function distinct from the functions of the other areas, we should also have a similar number of mental functions or faculties to correlate with them. Unfortunately for our purpose, the histologists have not attempted to give us the mental correlates of all the anatomically distinct areas, although in a few cases the anatomical reasoning and connections have led to certain psychological suppositions. It is in this way that we must account for the psychic areas of Campbell, and for some of the other psychological localizations which have been made.

An example of this anatomical reasoning is that of Campbell regarding the distribution of the sensory areas. In areas which were believed, because of the physiological and clinical evidence, to have sensory functions, Campbell observed that certain fibers "pursue a curious oblique course" different from other fibers in other neighboring areas. On the basis of this fact Campbell constructed other sensory areas, these latter areas being endowed by him with mental (*i. e.*, sensory) functions because in this one particular they had an appearance similar to that in supposedly known sensory fields. It did not appear to make any difference that these areas might have other well-marked differences. The main anatomical point is that these oblique fibers were discovered in different regions, and the important psychological point is that these minor similarities have been interpreted as indications of similarity of function of a mental order. In this case, Gall has been surpassed, and his phrenological reasoning outstripped.

The designation by Campbell of psychic areas, surrounding the so-called sensory areas, are interpretations of a phrenological nature of a supposed functional con-

nection of the primary receptive areas with these and of a relation of these areas to mental processes. In this there is a distinct psychological interpretation that the nervous impulses which start from the sense organs reach a part of the cerebral cortex and give rise to sensations, and that other nerve currents are sent to neighboring areas and give rise to perceptions.

Let us glance for a moment at the cortical area posterior to the fissure of Rolando. Campbell divided this region into two distinct zones (the postcentral and the intermediate postcentral) which are believed to be concerned with the afferent impulses from the skin and the underlying tissues. The zone bordering on the fissure, the postcentral, Campbell designates as "sensory," and that adjoining the first area "perceptive." In the first area the sensations of touch, of temperature, of pain and of movement are localized, and in the adjoining area (the intermediate postcentral) there are the psychic functions of localization of touches and also the so-called stereognostic sense. If we consider only the postcentral sensory area of Campbell, we might ask: Why should the same brain area be concerned with such unlike sensations as those which he attributes to it? By histological-phrenological reasoning we should have four, or even eight, distinct areas. Even though the gross sense organs have been differentiated, taste and smell, as sensations, are as much alike as are touch and pain and temperature and we might on anatomical grounds, if we closely follow Campbell, expect them to have seats in the same area. The observations of Cushing upon the effects of excitation of the postcentral area in conscious patients have not helped this attempt at a definite mental localization, and, in fact, they are decidedly opposed to it.

The motor area of the brain has been the

easiest for the anatomists to deal with, and it is the one to which they least often impute mental functions. In this connection, however, it is of interest to examine some of the evidence relating to this area to see how well its functions have been determined. In man this area is anterior to the fissure of Rolando, and is not simple. The cortex adjoining the fissure is to be differentiated from another anterior part and to these areas Campbell gives the names precentral and intermediate precentral. The primary part, that bordering upon the fissure, is the precentral, and this, according to Campbell, is bounded anteriorly by the other zone, which is physiologically connected with it. Stimulation of the cortex of the precentral area produces movements, and it has been a simple matter to explain the function by assuming that the cells govern the bodily musculature. But movement is also produced when the intermediate postcentral and other parts of the cortex are stimulated, and the latter movements are the more complex. In the precentral cortex the Betz cells are those to which the motor function has been imputed. These cells differ in number and in size in different parts of the precentral cortex, and these differences have been supposed to indicate functional differences, the use of the larger ones being variously interpreted as (*a*) indication of large movement, (*b*) of the extent of the nerve fiber or (*c*) of the number of muscle fibers which each controls. But differences in the sizes of these cells in the two hemispheres have been observed by Betz, and the larger size of those in the right hemisphere can not be explained in any of the ways that have been suggested. The Betz cells are reported to be absent in the guinea-pig, rabbit and rat, and we have no reason to suppose that these animals lack the ability to move or to coordinate

their movements. The recent studies have not usually been taken to suggest that the motor area is the seat or storehouse of motor memories, and in this respect there is a marked avoidance of a phrenological opportunity. Since the area is one of the most distinct histologically, and since it is one in connection with which extensive clinical and physiological observations have been made, it is of special interest that the histologists have been unable to explain in a satisfactory manner the reasons for the anatomical variations. Here, again, I would interpret the observations of Cushing and others on this area differently from Professor Pillsbury, who concludes that these results point to the non-mental function of this zone. We are not able to limit the localization of mental processes in this way, and, on the other hand, I do not believe that these observations can be interpreted as indications of a mental localization.

There are other facts which must be considered in relation to the localization of supposed mental functions in the motor area. The principal one is the phenomenon of nerve anastomosis. If two motor nerves are cut and the distal part of one be connected with the central part of another, and, conversely, the central part of the first be joined to the distal part of the second, there may be a return of function after a period of paralysis. We have no right to assume any anatomical alteration in the brain connections to account for this change, and the phenomenon has been interpreted, probably correctly, as a transfer of function. If this is to be interpreted in relation to any cerebral mental localization, it must surely be considered negative evidence.

In regard to some of the other so-called sensory fields we have almost as much information as regarding the one supposed

to be concerned with the sensations of touch, pain and temperature. Regarding the localization of mental states in these other areas, we have other suppositions which are to be believed as much as that regarding the mental functions of the post-central area. One of these, that the layers of the cortex in the so-called visuo-sensory sphere function to produce sensations of different color is a more bizarre supposition, and has even less clinical evidence in its support.

Many neurologists and some psychologists appear to believe that we have data which enable us to locate certain definite mental processes in parts of the cerebral cortex outside of the motor and sensory spheres. The disorders of speech, of the nature of aphasia, which are considered by some to be mental abnormalities, are due to localized injuries or destructions of parts of the brain. That the third frontal convolution, the area to which Broca assigned the function of motor speech, has a different structure than the surrounding regions, as has been contended by Brodmann, is a point made in favor of the localization of the speech function in this area. The criticisms of von Monakow and of Marie are, however, too trenchant to be disregarded, and the negative cases which they have cited are sufficient evidence that neither the mental processes connected with motor speech nor the supposed cortical speech mechanisms are definitely located in the part of the brain to which they were assigned by Broca, by Wernicke and by their followers.

One of the histologists has written: "It is unfortunate that we can not say that word deafness is invariably due to a lesion of the left superior temporal gyrus. Authentic cases have been recorded in which there has been no affection of this convolution and these, of course, increase our diffi-

culty in interpreting the condition." In another place he admits that the localization of this condition, even as a clinical phenomenon, rests upon only two cases which have been checked by careful post-mortem examination. Disregarding the number of cases which may properly be cited in support of the localization of this part of the speech function in this part of the cortex, it should be remembered that even one negative case is sufficient to demolish the whole structure of the mental speech function localization.

On the basis of the histological studies, we have also another kind of phrenological localization. This is a localization of particular processes of a mental order in certain layers of cells in the cortex. It will be remembered that the cortex is composed of rather distinct layers of cells with their fibers. Some histologists believe there are six layers, others five. Some of these layers have been disregarded in the formulation of the speculations. Bolton and Ariens Kappers believe that the layers have receptive and associative functions. Bolton disregards the first and fourth layers (he counts only five instead of six, as does Brodmann) and postulates the following functions for the other three layers: for the outer pyramidal layer he assumes a "psychic or associative function," for the third layer a receptive function, and for the fifth layer the function of lower voluntary and instinctive activity.

These facts indicate the general trend of the histological localization of function, and its tendency toward phrenology. What shall we say against this view or what shall be our attitude towards it? Brodmann assumes that the principle of localization has been settled, and all that needs to be done at present is to consider the "how" and "what" of localization. This view can not, however, be accepted.

It is the principle of localization which must be debated and settled. Whether it is the mental processes or cells which are localized is a matter which apparently the histologists and clinicians have not settled. It may be admitted that cells and cell groups are localized, and, although there is some doubt on the part of some clinicians, we may be willing to admit that certain symptoms are produced by definite lesions. We have, however, no evidence which will warrant the conclusion that mental states have been localized, and it is doubtful that many psychologists will believe in the crude histological localization of mental processes. The histological, the physiological and the clinical evidence warrants only a belief in the possibility of an association of brain lesions with motor, sensory and associational derangements, it does not warrant a belief in psychic localization.

Although it is apparent that mental states are not to be found spatially associated with definite areas distinguished from one another by histological and macroscopical characteristics, for practical purposes we must admit a close connection between the brain and mental processes. How then shall we conceive of the relation between the activities of the brain and mental states? The functions of the nervous cells, as functions, may include something which is at the basis of psychological states, but at the present time the physical and chemical activities of the cells can not be believed to be equivalents of the mental processes which may be concomitant with or the result of these activities. Since for practical purposes we may need some general principle of localization, we may say that mental processes are not due to the independent activities of individual parts of the brain, but to the activities of the brain as a whole. Here also I would not omit the cerebellum. It is well known that

similar mental processes may be inhibited by or may be lacking because of lesions in parts of the brain widely separated. This fact is the one at the basis of the diaschisis hypothesis of von Monakow. This hypothesis explains only certain clinical manifestations; it explains certain losses and how the same symptoms may be produced by diverse lesions. Conversely, it helps towards a proper understanding of the brain processes in connection with mental states. The individual parts of the brain do not work independently; they work interdependently, and it is because of the possible functional and anatomical connections that certain types or kinds of mental states are more in evidence than others. We should, on the physiological side, be not far wrong, if we compared the brain to a village or city as did Gregoire of Nice. There are paths and streets, definitely related to one another, but each independent to a certain extent. There are broad roads with many travelers, there are paths only occasionally traversed. There are houses from which the people come and to which they go; some pouring forth people in streams, others only occasionally; to some numerous people go and to others few. What goes on in the houses we can not tell. We can observe the "from" and the "where," the structure of the houses, and numerous other anatomical and histological facts, the effects of blocking of paths and streets and the destruction of houses, but the purposes of the travelers we do not know. We may have for the city a histological and a clinical localization, but this does not mean that we have also a mental localization.

From the anatomical and physiological standpoint, we deal solely with associations of an anatomical and physiological character. With these physiological associations mental processes are supposed to be

correlated. It is not necessary that we shall conclude that all of the mental processes are associational, and we must, in fact, admit that retention, and possibly other factors, in memory are not of this character. What memory means physiologically we do not know; where memories are stored we do not know; and how they are stored we do not know. All that we do know is that certain disturbances of the brain are accompanied by certain mental abnormalities, and that similar mental abnormalities are produced by or accompany diverse lesions. We have no facts which at present will enable us to locate the mental processes in the brain any better than they were located fifty years ago. That the mental processes may be due to cerebral activities we may believe, but with what anatomical elements the individual mental processes may be connected we do not know. Notwithstanding our ignorance, it would appear best and most scientific that we should not adhere to any of the phrenological systems, however scientific they may appear to be on the surface. We should be willing to stand with Brodmann, believing that mind is a function or an attribute of the brain as a whole, or is a concomitant of cerebral operations, but I at least am unwilling to stand with the histological localizationists on the ground of a special mental process for special cerebral areas or for special cerebral cell groups.

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We are requested to state that several teaching positions in the Imperial Pei-Yang University, Tientsin, China, are likely to be open as soon as stable conditions are restored in China. Applications should be sent to President S. H. Wang, Imperial Pei-Yang University, Tientsin. An application should contain: (1) a cable address so that the appli-

cant can be engaged by cable, if necessary, (2) a full statement of qualifications, especially practical and teaching experience, (3) age of applicant and other personal details, so that, in the absence of an interview some idea of the personality of the applicant can be obtained. The Imperial Pei-Yang University is the provincial University for Chih-li (the province which contains Peking), and its position in the educational system of China is similar to that which the state university of a correspondingly important state in the United States would occupy. This does not mean that it is comparable to the University of Wisconsin, for example. The university, founded in 1895 by Dr. Chas. D. Tenney, was destroyed in 1900 and rebuilt in 1902. Its present president is Wang Shoh-lien, a noted Chinese educator and man of affairs, a graduate of Woolwich, England. Of the numerous schools which are eventually to constitute the university only three have yet been organized, Law, Civil Engineering and Mining and Metallurgy. In 1910 the foreign staff consisted of two professors of law, three professors of civil engineering, one professor of mechanical engineering, a professor of history and economics, a professor of chemistry, a professor of mining and geology, and a professor of metallurgy, in addition to a numerous staff of Chinese professors and other officers. The courses of study in these schools are similar to those in American technical schools, but, as can readily be understood, the conditions surrounding the work are somewhat primitive, and make-shifts are often necessary. Nevertheless, Columbia University and the University of California have recognized the completion of the course in this university as equivalent to attaining the B.S. degree. A description of the university and its work can be found in *Engineering News* (one of the numbers during the autumn of 1910). All the work in technical subjects is done in English, though many of the students do not speak English with much ease or fluency. In some respects the equipment is quite complete, and in others it is lacking. The students are at

present comparatively few in number and in many cases their preparation is insufficient, but these disadvantages are being removed. The principal conditions of the contract which the university enters into with its professors provide for a three-year term of service. The salary is paid in silver at the rate of 300 Hongping taels per lunar month (the Hongping tael varies in value according to the rate of exchange, usually 60 cents to 65 cents; there are twelve and one third lunar months in the year). Free medical attendance is provided as well as suitable living quarters; these latter are substantial brick houses, provided with electric light and water. The traveling expenses of the professors to China and return are paid in the event of his completing his contract. The conditions of life in China are so different that it is impossible to convey an accurate idea of them in words. In general it may be said that any one who objects to unfamiliar and, in some respects, crude conditions of life and work would probably not enjoy the life in China, while others will find much of interest and pleasure in it. The cost of living is low, for \$1,500 per year a small family can live in much greater comfort than upon the same sum in America. It will be necessary for the applicant to sail from San Francisco during the first week in July, in order to begin work with the autumn term. More detailed information upon any points in doubt can be obtained by writing to Thos. T. Read, 420 Market Street, San Francisco, but any applicant should immediately send a letter containing the facts (1), (2), (3) to President Wang, stating, if necessary, that he is only tentatively a candidate, until fuller information is available. It must be remembered that the time available will not allow for many exchanges of letters and the final appointing will probably be done by cable. A copy of the application should be sent to Mr. Read.

SCIENTIFIC NOTES AND NEWS

It was proposed on behalf of the Royal Society and the Royal College of Surgeons that Lord Lister should be buried in West-

minster Abbey, and the consent of the dean was obtained. Lord Lister, however, had expressed a wish to be buried in Hampstead Churchyard, where the body of his wife lies. The first part of the funeral service was held in Westminster Abbey on February 16. Only members of the family were present at the interment in Hampstead Churchyard.

At the University of Pennsylvania exercises on Washington's birthday several honorary degrees were conferred, including the doctorate of laws on Dr. William J. Mayo, the surgeon; the doctorate of science on Carl Hering, the electrical engineer, and the doctorate of public hygiene on Dr. A. C. Abbott, professor in the university.

At the stated meeting of the committee on science and the arts of the Franklin Institute held on February 7 Elliott Cresson Medals were awarded as follows: Alexander Graham Bell, Sc.D., Ph.D., LL.D., of Washington, D. C., in recognition of the value of his solution of the problem of the electrical transmission of articulate speech. Samuel Wesley Stratton, D.Eng., Sc.D., of Washington, D.C., in recognition of his distinguished and directive work in physical science and metrology, and its application in the arts and industries. Albert A. Michelson, Sc.D., Ph.D., LL.D., of Chicago, Ill., in recognition of his original and fruitful investigations in the field of physical optics. Alfred Noble, C.E., LL.D., of New York, in recognition of his distinguished achievements in the field of civil engineering. Elihu Thomson, Sc.D., Ph.D., of Swampscott, Mass., in recognition of his leading and distinguished work in the industrial applications of electricity. Edward Williams Morley, Sc.D., Ph.D., LL.D., of West Hartford, Conn., in recognition of his important contributions to chemical science and particularly of his accurate determinations of fundamental magnitudes. Johann Friedrich Adolph von Baeyer, Ph.D., F.M.R.S., of Munich, Germany, in recognition of the many important results of his extended research in organic chemistry and of his discovery of synthetic processes of great industrial value.

Sir William Crookes, D.Sc., LL.D., F.R.S., O.M., of London, England, in recognition of his important discoveries in inorganic and analytical chemistry and of his pioneer work on the discharge of electricity through gases. Sir Henry Enfield Roscoe, Ph.D., LL.D., D.C.L., F.R.S., of London, England, in recognition of his extended and important researches in the domains of inorganic, physical and industrial chemistry.

SINCE Henry Shaw's death, in 1889, over \$400,000 has been paid in special street and sewer taxes and the like, for improvement of unproductive endowment property—two thirds as much has been spent in keeping up the grounds and plant houses and increasing the collection of plants at Shaw's Garden. This burden is now nearly lifted and income from the newly improved property as well as the full return from that which has always been productive is to become rapidly available for very large extensions and increased beautification of the garden. Carrying out the proposed improvements is expected so fully to occupy the time of the director that the trustees and Dr. Trelease, who has acted *ex officio* as a trustee for the last three years, are agreed that this development should be undertaken by a man who is free to give his entire effort to it, while the scientific work that Dr. Trelease has under way or in contemplation is sufficient to call for further freedom of his time from administrative encroachment. For these reasons Dr. Trelease, who has been director of the Missouri Botanical Garden since the death of its founder, in 1889, has asked to be relieved from the responsibilities of the office at the earliest convenience of the trustees, and intends, after this request has been granted, to give his entire time for the present to the completion and publication of a number of research papers on which he is now working, and which will involve study in the herbaria as well as at the St. Louis garden.

DR. GEORGE H. ASHLEY, state geologist of Tennessee, will resign to accept a position with the U. S. Geological Survey as a member

of the land classification board in charge of the coal work.

PROFESSOR MARSTON TAYLOR BOGERT, of Columbia University, has been appointed chairman of the American Commission on Organic Nomenclature, the other members of which are President Ira Remsen, of Johns Hopkins University; Professors W. A. Noyes, of the University of Illinois; T. B. Johnson, of Yale University; J. B. Tingle, of McMaster University; J. F. Norris, of Simmons College; M. Gomberg, of the University of Michigan, and Dr. C. S. Hudson, of the Bureau of Chemistry, U. S. Department of Agriculture. The commission will cooperate with similar national bodies in other countries in the revision of the nomenclature of organic compounds. The chairman will be glad to receive suggestions from American organic chemists.

PROFESSOR P. G. HOLDEN, head of the department of agricultural extension of Iowa State College, has resigned his position to engage in an active campaign for nomination for the governorship of Iowa on the Republican ticket. R. K. Bliss has been made acting head of the department.

DR. H. VON GROTH, professor of mineralogy at Munich, has been elected an honorary member of the London Chemical Society.

DR. F. W. DYSON, F.R.S., has been elected president of the Royal Astronomical Society.

PROFESSOR P. ANDOYER has been elected president of the French Mathematical Society.

PROFESSOR JOHN JOLY, F.R.S., has been appointed Huxley lecturer at Birmingham University for the current session.

DR. J. M. MCBRYDE, former president of the University of South Carolina, later president of the Virginia Polytechnic Institute, and now on the Carnegie Foundation, was awarded the McMaster medal by the University of South Carolina at the celebration of Founder's Day on January 12, 1912. The McMaster medal is awarded annually by the University of South Carolina to an alumnus or former student of the university for "distinguished service to mankind."

PROFESSOR RENÉ ZEILLER, the eminent paleobotanist of the Paris School of Mines and inspector general of mines, has been appointed president of the council general of mines, a public board under the Ministry of Public Works.

DR. W. WILIM, of the St. Petersburg Academy of Science, has been appointed director of the newly-established seismographic observatory at Pulkova.

MR. GEORGE H. CLAPPS has been appointed to represent the Academy of Natural Sciences of Philadelphia on the occasion of the celebration of the one hundredth and twenty-fifth anniversary of the founding of the University of Pittsburgh. The council of the Société Géologique de France has appointed one of the foreign members of the society, Dr. C. R. Eastman, of the Carnegie Museum, to act as official representative of that body at the celebration.

A SMITHSONIAN expedition, under the direction of Mr. H. C. Raven, will start in a few days for eastern Dutch Borneo, where a collection of vertebrates and ethnological material will be made for the United States National Museum.

MR. WALDEMAR T. SCHALLER, chemist and mineralogist of the United States Geological Survey, is soon to leave Washington for a six-months' trip to Europe where he will visit the principal mineral collections and continue his studies at the universities of Heidelberg and Munich.

DR. WARREN D. SMITH, chief of the division of mines, Bureau of Science, Manila, will be on leave in the spring and summer of 1912 in the United States, making visits to the various laboratories in Washington and Pittsburgh. Later he will spend a month in one of the California oil fields investigating the geology and operations there.

PROFESSOR GEORGE D. HUBBARD, head of the department of geology in Oberlin College, is engaged in special research under the Ohio State Geological Survey, in the attempt to formulate some definite conclusions regard-

ing the problems of pre-glacial drainage in the Ohio Valley.

PROFESSOR WILHELM PASZKOWSKI, the director of the Scientific Information Bureau of the University of Berlin, will leave for the United States on March 9, to deliver a series of lectures on German culture on the invitation of the Germanic Society of New York. He is to lecture at Columbia, Harvard, Yale and other universities.

PROFESSOR CASPER RENÉ GREGORY, of the University of Leipzig, is giving a series of lectures at the University of Illinois on "The Development of Science in Germany." Dr. Gregory is the first American-born professor to receive appointment in a German university. He holds the chair of theology at Leipzig.

DR. HAVEN METCALF, of the U. S. Department of Agriculture, delivered on February 17 the John Lewis Russell lecture before the Massachusetts Horticultural Society. His subject was "Fungous Diseases of the Chestnut and Other Trees."

LECTURES have been given before the graduate students in highway engineering at Columbia University by Mr. Clifford Richardson, consulting engineer, New York City, on "Trinidad and Bermudez Asphalts and Their Use in Highway Construction"; by Mr. Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment, New York City, on "Design of Highways and Systems of Highways," and by Mr. A. W. Dow, chemical and consulting paving engineer, New York City, on "The Inspection of Sheet Asphalt Pavements."

PROFESSOR ARTHUR KEITH, curator of the museum, began on February 26 a course of six lectures at the Royal College of Surgeons of England, on phases in the evolution of man.

ON February 24 Sir J. J. Thomson began a course of six lectures at the Royal Institution on "Molecular Physics."

CHARLES ROBERT SANGER, Ph.D., professor of chemistry and director of the chemical laboratory at Harvard University, died on February 25, at the age of fifty-two years.

THE REV. FRANCIS BASHFORTH, distinguished by his experiments in ballistics, formerly professor of applied mathematics at Woolwich, died on February 12, at ninety-three years of age.

M. JACOB AMSLER, corresponding member of the Paris Academy of Sciences in the section of mechanics, has died at the age of eighty-nine years.

THE New York State Civil Service Commission announces among other examinations that of medical superintendent at the Matteawan State Hospital for the Insane at a salary of \$3,000, with maintenance for the superintendent and his family, and of specialist in agricultural education at a salary of \$2,500.

THE Kaiser Wilhelm Foundation for the Advancement of Science has under consideration the establishment of a biological research institution.

MR. W. LEO BULLER has presented to the Dominion Museum, Wellington, New Zealand, a collection of about 700 Maori ethnological specimens which had been collected by his father, Sir Walter Buller.

ACCORDING to a note in *Nature* the possibility of the discovery of a remedy for cancer has been advanced a stage by the preparation of Professor Wassermann, of Berlin, of a substance which possesses a curative action experimentally on cancer of mice. Professor Wassermann reasoned that since the cancer-cells are growing rapidly, their oxygen requirements would be different from, and greater than, those of the cells of the body generally. He sought for some substance which might interfere with the oxygen supply to the cancer-cells, and finally adopted selenium as a means to do this. The next problem was to convey selenium to the cancer-cells by means of the blood stream, and after testing some hundreds of preparations a compound of selenium with an aniline dye eosin was found to fulfil this condition. If the eosin-selenium compound is injected into a healthy mouse it becomes pink all over, but if into a mouse with a cancerous tumor the tumor only becomes colored,

demonstrating the selective absorption of the substance. After two or three injections of the substance into a mouse the subject of cancerous tumors, the tumors are found to have softened, and after six to eight doses they become cystic, diminish in size and finally disappear, and no recurrence takes place. The eosin-selenium compound is, however, poisonous, and a certain number of mice succumb under the treatment. Moreover, only small tumors (up to the size of a cherry) are definitely cured; with larger tumors so much disturbance ensues that the animals die.

THE U. S. Bureau of Education has recently issued Bulletins Numbers 13 and 16 for 1911, the former containing the Report of the American Committees I. and II., on Mathematics in the Elementary Schools of the United States, and the latter containing the Report of the American Committees III. and IV., on Mathematics in the Public and Private Secondary Schools. These reports are prepared under the direction of the American commissioners of the International Commission on the Teaching of Mathematics. They may be secured by addressing the U. S. Commissioner of Education at Washington.

IN commemoration of the seventieth birthday of Professor J. J. Rein, January 27, 1905, the friends of this well-known German geographer instituted a fund, the yearly income of which should be devoted to the furtherance of geographical research. We learn from the *Geographical Journal* that the contributions made then and since to the fund reached, in November last, a total of nearly 9,000 marks, and in the same month the rules for the administration of the fund were drawn up. It is proposed, unless reason to the contrary should arise, to wait until the fund has accumulated to 10,000 marks before making a grant of the interest, which alone is to be expended, the capital remaining intact. Grants will be made with a view to giving young geographers the opportunity of travel and research, and the recipients must be Germans or Japanese, while preference will be given to students in the University of Bonn and in the Commercial College at Cologne. The fund will be admin-

istered by a small committee, on which Professor Rein will serve during his lifetime.

Nature states that the council of the Royal Sanitary Institute offers the Henry Saxon Snell prize for competition this year. The prize was founded to encourage improvements in the construction or adaptation of sanitary appliances, and is to be awarded by the council at intervals of three years, the funds being provided by the legacy left by the late Henry Saxon Snell. The prize will consist of fifty guineas and the silver medal of the institute, and is offered for an essay on "Suggestions for Improvements in the Ventilating, Lighting, Heating and Water Supply Appliances and Fittings for an Operating Room and its Accessory Rooms for a General Hospital of 400 Beds."

THE conference of representatives of forty-two states which was convened last November under the auspices of the International Office of Public Hygiene, and which has been sitting in Paris under the presidency of M. Camille Barrère, the French ambassador in Rome, has now signed a convention making regulations for the prevention of pestilential diseases, especially plague, cholera and yellow fever. This agreement supplements the earlier Paris convention of 1903 in accordance with the latest scientific requirements.

THE annual meeting of the Illinois Society of Engineers and Surveyors for 1912 was held at the University of Illinois on January 17, 18 and 19. The more important engineering topics discussed were stream pollution, sewage disposal, accuracy in surveying, road and pavement problems and the bridge work of the Illinois highway commission. Two illustrated lectures were given, one by Professor I. O. Baker on the Panama Canal, and one by Mr. H. L. Cooper, chief engineer, on the Keokuk Water Power Plant. An afternoon was spent in inspecting the buildings and discussing the work of the College of Engineering.

THE Physical Science Club of Oberlin College is an organization composed of instructors and students in the departments of chemistry and physics, with affiliated members

drawn from the departments of botany and zoology and mathematics. The most recent open meeting of the club was devoted to a lecture by Professor A. W. Menzies, of the University of Chicago, who spoke on "The Uses of Quartz in Physical and Chemical Apparatus." Recent regular meetings of the club have been devoted to talks and illustrated lectures by E. J. Moore, associate professor of physics, who has been for two years working in the laboratories of the University of Chicago under Professor Millikan. Dr. S. R. Williams, head of the department of physics, has read a series of papers on "A Model of the Elementary Magnet," while Professor G. D. Hubbard, head of the department of geology, has brought to the meetings the results of his work under the State Geological Survey, on the investigation of preglacial conditions and present topography in the Ohio Valley.

In connection with the Centenary Celebration of the Academy of Natural Sciences of Philadelphia, the following invitation has been mailed to correspondents.

The Academy of Natural Sciences of Philadelphia, founded in the year eighteen hundred and twelve for the cultivation of the natural sciences, in March nineteen hundred and twelve will have completed one hundred years of active devotion to this purpose.

For the adequate celebration of its centenary anniversary the Academy will call in convention at its Hall the learned men and institutions of the world—its collaborators.

The Academy has the honor to invite to be present at this event which will take place at Philadelphia on Tuesday, Wednesday and Thursday, the nineteenth, twentieth and twenty-first of March nineteen hundred and twelve.

UNIVERSITY AND EDUCATIONAL NEWS

THE council of Bedford College has announced that the £100,000 required to erect the new buildings at Regent's Park and to inaugurate an endowment fund has now been obtained. Of this amount the London County Council has contributed £30,000.

PROFESSOR HENRY WILLIAMSON HAYNES has bequeathed to the Peabody Museum of Har-

vard University \$1,000 for the library and all his prehistoric and archeological objects, and his books and pamphlets relating to such subjects. To the Boston Society of Natural History is given his fossils, minerals and other objects of natural history. To Harvard College is given, for its classical department, Mr. Haynes's Etruscan, Greek and Roman vases and his ancient coins and medals. The Boston Museum of Fine Arts is to receive his Egyptian antiquities, except those relating to the age of stone in Egypt, which go to the Peabody Museum.

THE dedication of the New York State Education Building will take place on October 15-17. It is expected that educational officers of other states will attend the exercises and that the leading institutions—including libraries and museums as well as universities, colleges and schools—of this and other countries will be represented by delegates.

THE entrance requirement to the College of Medicine of the University of Cincinnati will be advanced to include two premedical years in science, after June 1, 1913.

ANNOUNCEMENT is made that at the University of Pittsburgh instruction in geology, paleontology and physiography will hereafter be given under the direction of the college instead of the School of Mines faculty, courses being offered in the department of geology by the following-named professors and instructors: Drs. C. R. Eastman (chairman), A. E. Ortmann, O. E. Jennings and Messrs. H. N. Eaton and Earl Douglass.

PROFESSOR H. R. SMITH, in charge of the animal husbandry work in the University of Nebraska, and Professor F. H. Stoneburn, professor of poultry husbandry in the Connecticut Agricultural College, have been called to the University of Minnesota.

MR. C. W. HOWARD, of Cornell, known in connection with grasshopper work in South Africa and at present with the Rockefeller Institute, has been appointed to an instructorship in the division of entomology, University of Minnesota. Mr. O. G. Babcock, of College

Park, Maryland, has been appointed as assistant to the entomological division in charge of the insectary. These two appointees take the places of Mr. C. S. Spooner and Mr. H. B. Scammell, respectively. The former goes to Georgia, accepting an offer from the state entomologist there, and the latter has been elected county inspector of nurseries and orchards in Colorado.

DR. B. W. VAN RIPER, of Nebraska Wesleyan University, has been elected assistant professor of philosophy in Boston University.

AT Smith College Elizabeth Kemper Adams has been promoted from associate professor of philosophy and education to professor of education; Aida Agnes Heine, from instructor to associate professor of geology, and Helen Ashurst Choate, from assistant to instructor in botany.

DISCUSSION AND CORRESPONDENCE

THE PRIBILOF FUR SEAL HERD

IN SCIENCE of February 2, 1912, Mr. McLean, of the Campfire Club's Committee on Game Protection, says, among other things about the diminishing fur seal herd, that "the best remedy is to let it absolutely alone."

Nature's methods are wasteful,

So careful of the type she seems,
So careless of the single life.

Civilized countries practise artificial fertilization of fish eggs, and rearing of the fry in hatcheries, because a greater proportion of eggs can be fertilized, and vastly more young brought to maturity, than by nature's methods. The domestication and control of useful animals is universally practised for similar reasons.

That the fur seal tribe would slowly increase if "let absolutely alone" may be true. So would most other beings we are at such pains to cultivate. Pelagic sealing is responsible for the present abnormal condition of the seal herd. The state department's bill for the ratification of the treaty for the suppression of such sealing, *gives the female seals the first chance they have had for twenty-five years*. The fact that we have forty thousand breeding females on the

islands to-day is attributable to our consistently practised rule of keeping down the hordes of dangerous males on land, while pelagic sealers were destroying the female stock.

The Bureau of Fisheries should not be hampered in carrying out its arrangements for a more rapid increase of the herd than nature unaided can effect.

Great Britain, Japan and Russia are to profit by the cessation of pelagic sealing, and ill-advised amendments would render the treaty ineffective, which would be deplorable. A naturalist and a member of the fur-seal investigation commission of 1896-97 for Great Britain, now writes me that

There is no doubt that fighting bulls have caused incalculable injury to the seal rookeries, and judicious killing of the males should be carried on from the date that there is known to be more than a sufficient supply for breeding purposes. There is no doubt that with proper management an increasing number of the surplus males may be killed every year with great advantage to the rookeries.

This is talk from a man who worked with us for several seasons on the Pribilofs.

Are the dozen or more naturalists who have devoted many seasons to studying the fur seal on the Pribilofs, and have long worked for the cessation of pelagic sealing, to be deprived in the end, of the opportunity to put into practice what they believe to be a rational system of fur-seal farming. If congress should be persuaded to let sentimentalists dictate the policy to be pursued on the national seal farm, it would mean a *very slow rehabilitation of the seal herd*. We can not afford to ignore what has been learned about the fur seal by the patient investigations of the past twenty years, and take a step backward.

Last November I had some correspondence with a member of the house of representatives who was taking the agitation of the Campfire Club against the killing of surplus male seals very seriously. I quote the following from a letter I wrote to him at that time:

In order to prevent annual loss of new-born young we must prevent the flooding of the breed-

ing grounds by big *males*. The logical way to do this is to market a large proportion of the three-year-olds, as we always have done, and thus prevent them from growing up into valueless but dangerous and destructive supernumeraries.

I take exception to the line in your letter "unless the herd is further depleted by the Bureau of Fisheries." The herd is not to be "depleted," as the females are already saved for fifteen years by the cessation of pelagic sealing, but the polygamous *male part of the herd* must be depleted (to quote your word again) if you propose to mature all your annual crop of infant seals. Nature will do the *depleting* if you don't, and *half the loss will be female pups*.

Surplus bull seals are of no more use than surplus rams or roosters. By saving them you will lose, in fifteen years, not less than \$15,000,000 of revenue.

The present revenue from the islands is over \$400,000 a year, which in fifteen years would amount to \$6,000,000, *without any increase of females*. But the females will increase, and the loss of revenue will exceed \$15,000,000 in fifteen years closed season, and you will lose an important percentage of pups besides.

This is not the first time I have endeavored to prevent well-meaning congressmen from being deceived by the misrepresentations which have been poured upon them for many years. The mischief-maker referred to has bobbed up every other year for the past eighteen years and has been discredited every time. I hope you will look up his record as just published in H. R. Doc. 93, 62d Congress, 1st Session, pp. 1153-62.

The member of the house to whom I sent this letter has at last presented an amendment to the State Department bill in which he proposes to limit the killing of male seals to 5,000 a year for five years, 7,500 a year for the following five years and 10,000 annually for five years after that. At the end of fifteen years new regulations to be adopted.

Now that is better. The gentleman has evidently been thinking it over. We shouldn't probably kill much closer if allowed to have our own way. Perhaps by the time the treaty bill reaches the senate, congress will decide that the Bureau of Fisheries is able to handle the seal fishery safely for the seal herd and for the government.

As to the criticism of my general statement about the *Uncinaria* parasite, I can only reply that our diminished rookeries are *not at present overspreading into the parasite-infected sand areas*. In fact, Mr. Heath states, as quoted by Mr. McLean, "these areas have been abandoned." They must of course be fenced to protect the younger seals from infection as soon as the breeding grounds begin to expand. As to shooting some of the big males when they get too numerous, it would puzzle the experts, as well as Mr. McLean, to say which were the fittest to survive. They all look alike. Old Ocean attends to the matter of selection in the case of the fur seal, weaklings do not survive the seven-month's migration swim among the killer whales of the Pacific. If Mr. McLean will bring his committee to my office where there is a fairly complete set of rookery photographs and charts, he will get a clearer understanding of the Pribilof breeding grounds than he has at present. The fact is that the innocent Camp Fire Club is being used by the unscrupulous lobby which has always been kept at work by the pelagic sealers. One excuse suits it as well as another, this time it is the killing of surplus males. It is a pity that year after year it should succeed in getting the support of men of good standing who happen to be ignorant of the real facts involved.

C. H. TOWNSEND,
Member Advisory Board
Fur Seal Service

TO THE EDITOR OF SCIENCE: In SCIENCE for February 2, Mr. Marshall McLean, member of the Camp Fire Club, enters the list of those who would by indirection ruin the fur seal herd. He would have "natural conditions" rule upon the fur seal islands and "all killing of selected males for commercial purposes . . . cease until the tide of increase in the fur seal herd has once more set toward the flood." He lays down as reason for this the principle "that when any species of wild animal has become so depleted as to be in danger of extinction, the best remedy is to let it absolutely alone."

Singularly enough he quotes President David Starr Jordan in support of his position. The quotation, however, is from an essay on the effects of war, the selection of the most fit for military service and their destruction in war tending to reverse the process of natural selection under which the fittest should survive. The assumption of Mr. McLean is that the killing of fur seals, as practised on the islands, is a selection out of the best, leaving an inferior quality of males to breed. President Jordan would not admit this and is in fact utterly opposed to any scheme for the suspension of land killing as at present conducted.

To do President Jordan justice in the fur seal matter quotation should be made from his reports on this subject which followed the investigations made in 1896-97 under his direction. On page 147 of Vol. 1 of the final report of the Commission, speaking of a *modus vivendi* similar to the one which Mr. McLean would institute, which prevailed in 1891-93, he says:

The suspension of killing on land only released young males to grow up which are now, as idle and superfluous bulls, a menace to the rookeries.

Again, on page 120 of the same volume,

Moreover, the removal of this superfluous male life is not only possible, but it is really beneficial to the herd. The only deaths among the adult bulls and cows, discovered upon the rookeries of the islands, resulted from the struggling of the bulls among themselves or to attain possession of the cows.

In the investigation of 1896-97 a number of eminent scientists from the Smithsonian Institution were associated with President Jordan and a commission of British scientists made a concurrent investigation. These men came together as a joint Conference of Fur Seal Experts in Washington at the close of the investigation and agreed upon a statement of facts regarding the fur seals. The full text of the finding of fact of this Conference will be found on pages 240-244 of Vol. 1 of the final report of the American Commission.

Mr. McLean should read this document. In Article 9 occurs this statement:

The methods of driving and killing practised on the islands, as they have come under our observation during the past two years, call for no criticism or objection. An adequate supply of bulls is present on the rookeries; the number of older bachelors rejected in the drives during the period in question is such as to safeguard in the immediate future a similarly adequate supply; the breeding bulls, females and pups on the breeding rookeries are not disturbed; there is no evidence or sign of impairment, by driving, of the vitality of males; the operations of driving and killing are conducted skillfully and without inhumanity.

In Article 13 it is further stated:

The polygamous habit of the animal, coupled with an equal birthrate of the two sexes, permits a large number of males to be removed with impunity from the herd, while, as with other animals, any similar abstraction of females checks or lessens the herd's increase, or when carried further, brings about an actual diminution of the herd.

Passing to the side of pelagic sealing the Conference of Experts has this to say:

Article 11. Pelagic sealing involves the killing of males and females alike, without discrimination and in proportion as the two sexes coexist in the sea. . . . In 1895 Mr. A. B. Alexander, on behalf of the government of the United States, found 62.3 per cent. of females in the catch of the *Dora Seward* in Bering Sea, and in 1896 Mr. Andrew Halkett, on behalf of the Canadian government, found 84.2 per cent. in the catch of the same schooner in the same sea.

These quotations from the findings of fact of the experts are more guarded than would have been the same statements made by the American Commission alone, but they state with sufficient clearness the effect of land killing and pelagic killing in their relation to the herd. They offer little support to the contention of Mr. McLean.

At the same time President Jordan would recognize that the law of the survival of the fittest applies to the fur seals. The seat of the operation of this law is, however, at sea and not on the land. The fur seals spend the winter in the open ocean. They get all their

food at sea. The difficulty of obtaining food and the buffeting of the severe northern winter constitute the sifting process by which the weak and ineffective fur seal, male or female, is ruthlessly weeded out, leaving only those that are absolutely fit to return to the islands in the spring. The killing gang does not select out the best. They are all alike good. It selects its animals by ages, an animal of three years giving a larger and hence more valuable skin.

But the question at issue is not a theoretical one. For the past fifteen years pelagic sealing has been the recognized sole cause of the decline of the fur seal herd. On July 7 last the United States secured the agreement of Great Britain, Russia and Japan to a treaty for the abolition of this form of sealing. This treaty obligates the United States to pay to Canada and Japan fifteen per cent. each of its land catch, these nations buying off their pelagic sealers. It is only necessary to put this treaty in effect by act of Congress, the Sulzer bill now before the House having this end in view. But opposition to the bill arises. It takes the form of an amendment providing for a "zaposka" or close season of fifteen years, coincident with the term of the treaty, in which there shall be no land sealing. That is, the government is to have no land catch to share with the cooperating nations. They will become dissatisfied, withdraw from the treaty, and pelagic sealing will be resumed. Such is the inevitable trend of this misguided effort to which the Camp Fire Club is wittingly or unwittingly lending itself.

The principle laid down by Mr. McLean may apply to pairing animals like the deer, bear, duck or quail. But the fur seal is a polygamous animal and has nothing in common with these wild creatures. Its true analogies are with the domestic animals—cattle, horses, sheep, poultry—which man handles for his comfort or profit and from which he regularly removes the superfluous males without damage to the breeding stock. Would Mr. McLean have us believe that the way to recuperate a herd of cattle that had fallen into decline

through the illicit killing of its cows and calves was to leave it absolutely alone? A cattle man would stop the killing of the females and young, would look out for a reserve of bulls, and market his steers as usual. Especially would he do this if it were necessary for him to pay for the cooperation of his neighbors in suppressing the illicit killing.

Mr. McLean would have us take a different course. He would have the government begin by depriving itself of an immediate income of about \$400,000. The herd has probably yielded this amount in the lowest year of its existence. This income has possibilities of indefinite increase with the recovering herd. But there would be no increase. With no quota to share with the cooperating nations the treaty would lapse. Pelagic sealing would be resumed. The herd would continue on its way to extinction. Is this what Mr. McLean and the Camp Fire Club want?

GEORGE ARCHIBALD CLARK

STANFORD UNIVERSITY, CALIF.,

February 7, 1912

ANOTHER VIEW OF THE PRINCIPLES OF WATER-
POWER DEVELOPMENT

IN SCIENCE of December 15 the foremost place is given to Dr. W J McGee's statement of the above-mentioned principles. As the subject is one of general scientific interest, I beg leave to present it from a different point of view.

A couple of centuries of legislation, following decade by decade the settlement of the country and the appropriation and use of its waters for power, irrigation, etc., have left little scope for the application of Dr. McGee's principles, at least on the part of the federal government. He writes as if he were laying out plans for a continent not yet occupied by human beings. It may as well be recognized that in the older part of the United States the more desirable water powers have all passed completely into private ownership. The practical application of his principles, if there be any, must then be in the newer, and chiefly the western, part of the United States. But

even here irrigation waters are already appropriated very generally except in those not rare cases where a large capital is required for the first installation. Water-power can not be dissociated from the subject of irrigation in the west, because the same water often serves both purposes, and may even be taken away from one to serve the other. It is surprising to see all through the west that every spot where irrigation can be cheaply applied to good soil has been farmed with the aid of water for many years. Many cases have come under my observation, from forty to a hundred miles from a railroad, where irrigation has been practised for thirty or forty years, generally up to the limit of the water supply or of the good land. It is very late in the day to talk about the general principles which should govern the framing of laws on irrigation, but it is astounding to read (McGee's principles 34 and 36) that legislation at present should be tentative and experimental. Every western state has voluminous laws on the subject, and ten times more voluminous legal decisions on those laws. The general principle has had full acceptance for a long time that the states have complete authority over the use of waters within their respective borders except for the purpose of navigation and in a few unusual cases. While there is a "borderland" here that is not worked out, there is no reason to suppose that the general control of its own irrigation waters by the state will be materially impaired.

This control necessarily extends to the public lands within the state. In nearly every case where the settler puts in a small irrigation system for his own use, his head-gate and the most of his ditch are on government land, since he has to go some distance above his own land to get the fall requisite. A later homesteader above him can not disturb his ditches, even though occupying a tract across which they run. This policy runs back almost beyond history, and is as well settled as anything can be.

Turning now to the subject of water-power, we find that all the western states have pro-

vided definite methods by which it may be appropriated, as in the case of irrigation waters. Even on public lands the authority of the state has until lately not been questioned. But with the rise of the conservation movement there has come about a demand that the federal government assert a right to the disposal of water-powers on public land, and especially in national forests. This demand has its origin in the belief that the western states are allowing the water-powers to be monopolized, and are in danger of losing all right of subsequent regulation, so that the public served by the power will be compelled to pay "all that the traffic will bear."

In the absence of any explicit law or precedent for federal interference with water for power or irrigation, the proponents of the policy have grasped at general constitutional powers, such as "to promote the general welfare," or the right to control navigation in rivers and internal waters. President Taft a year ago favored the assertion of a claim to the banks of the stream by the federal government, so that the *site* would become paramount to the *water* in a power installation, conceding that the state had exclusive jurisdiction over the latter; the interposition of a technical claim to the stream banks would, in his opinion, operate to prevent the establishment of any power plants without federal approval, even though the government had no claim on the water. This admittedly technical and strained position is just about paralleled by his proposal that, since we have solemnly pledged our word to other nations that we will make the tolls in the Panama Canal equal to all, we will make some sort of a subsequent gift to our own vessels to equal the fees paid by them. The good intention we all concede, but lament the facile readiness to "beat the devil about the stump."

This is not the place for an adequate discussion of the safeguards which the western states have placed around the disposal of water power, nor for a description of the propaganda by which, largely through misrepresentation, many people have been made to believe that

only in federal control could there be any assurance of permanent management in the interest of the people. Enough to mention that fundamental safeguards are two—forfeiture for non-use, and the reservation of regulatory powers by the state. Both of these are embodied in the constitution of Idaho.

But the most notable principle enunciated by Dr. McGee is his No. 30. It is as follows:

30. The essential principle of natural equity on which specific legislation may rest has already found expression, both by statesmen and by powerful associations of citizens including both jurists and publicists, in the incontrovertible proposition—now become axiomatic—that *all the water belongs to all the people.*

So far is this principle from being true, either legally, equitably, or even as an ideal relation, that the reasonableness of the opposite view will appear immediately on stating it. If Dr. McGee is correct, then the general government should collect as a tax on every water power the full value of the power above a reasonable interest on the cost of installation; from every user of irrigation water it should collect the difference in value between what will grow with water and without it, minus the cost of applying the water; from every municipality a tax on its use of water; even from the owner of a well a proportionate assessment. Otherwise the people as a whole can not derive the benefit which their ownership of all the water ought to entitle them to. A closer analysis would necessitate even a farther extension of water taxation, for it is obviously unjust to tax the western user of irrigating water while the eastern farmer is allowed the free use of rain-water. Such are the absurdities into which we are led if we admit the principle that all the water belongs to all the people.

Is it possible to express in a simple way the correct principle as to ownership of water? Not in all relations, because of their variety. But some are unquestioned: a man owns the water in his well, we all believe; he has a right to the benefit of what falls from the sky on his land; communities rightly own the water that flows through their mains to their citi-

zens. So far all agree that the present legal relations could not be improved; they are substantially ideal.

How about water for irrigation? Prior use is the determining element in ownership, according to the laws in all the western states, and continuity of use is the element which perpetuates the title. This is the simplest possible plan, and taken all in all is the most feasible one, and works as little hardship as any.

Now about water for power. This is the "nub" of the whole matter for the conservationist, and is probably all that Dr. McGee had in mind in enunciating his principle, which seems so fundamental to him as to be "axiomatic," "incontrovertible," and even (principle 38) "a part of the body of ethical conviction underlying American character and constituting its strength." In the face of these overwhelming assertions, I will undertake to maintain that the people as a whole have no interest whatever in any specific water power. A portion of the people are in each case interested, those who are in a position to make a reasonable use of the benefits of the power, but the rest have no right whatever to claim a share by taxing those more favorably situated with reference to this particular power site. To illustrate: the Snake River in southern Idaho has several large falls, principal among them being Shoshone Falls, with Twin Falls second. These have been partially developed, and a large amount of power, light and heat can be obtained from the present installation. Now what part of the people of the United States are equitably interested in what is being done here? Simply those who live within the range of power transmission, and are not more accessible to another source of power. These people, in a very real sense, have an interest in that water power, and have a right to be protected from extortion by the laws of the state, and as a matter of fact they have a recourse in the constitution of Idaho. But the people of Cape Cod, or of Washington, D. C., have no equity in Shoshone Falls, and no right to expect dividends from its successful development. This is not

only ideally sound in principle, but it is recognized in law and embedded in the whole organization of state and nation.

Differences of opinion in regard to policies of conservation have had their origin very largely in loose and vague thinking such as is illustrated by Dr. McGee's principles. Not realizing that the west has been facing these problems for decades, and has pretty nearly settled them, a class of theorists in the east has taken up the same subjects *de novo*, treating them as if they had never before been touched by the hand of man and the way were free for any sort of plan to be carried out.¹ I do not accuse all conservationists of being so visionary, but Dr. McGee represents something of an element. It wearies the patience of the people of the west to be obliged to deal with such persons, who have a missionary zeal to teach us things we have always known, and know much better than the would-be teachers, and who would view us as either a set of thieves and robbers or helpless children whom they would protect. Our best reliance is ourselves; we are amply clothed with authority to do all that is necessary; our experience and training have familiarized us with the work ahead; and our purpose is to protect the interests of the public, our own public, ourselves, in all necessary and reasonable ways.

J. M. ALDRICH

FIRST USE OF WORD "GENOTYPE"

I HAVE recently asked Dr. J. A. Allen, the leading authority in this country on nomen-

¹A beautiful illustration, which I will not charge to Dr. McGee, is in the withdrawal of power sites from entry under the public land laws. It was a great relief to many eastern conservationists when sweeping withdrawals of this class were made a few years ago; but in fact under the laws of Idaho the acquisition of a water power is a process entirely apart from the filing of any sort of entry on land, and the withdrawal did not change the legal status of the power sites by one iota. The mode of acquisition of water power under the laws of the state is precisely the same as before, and I doubt not that the same is true in other western states.

clature, to express an opinion upon the first use of the word "genotype." He writes, January 30, as follows:

I can not give the date of the first introduction of this word to replace the phrase "generic type," but I find it was used as early as 1903, as apparently a word not new. By 1905 it was in common use in discussions of generic types and prior to 1910 it became officially adopted by the International Zoological Commission. I think the first use of the word was by some writer in *Nature* or in the *Annals and Magazine of Natural History*.

The word is derived from the Greek word *γένος* = kind, genus and *τύπος* = type. The use of "o" as a connecting vowel seems to be consistent with general usage in such cases. The derivation of "genetic" is given in the Century Dictionary as from *γένεσις* = generation, genesis.

I will try to trace it to its origin, and, if successful, report again on the subject.

This note by Dr. Allen raises the question as to the use of "o" as the connecting vowel in the term "genotype" proposed by Johannsen. Why not use "e" as the connecting vowel, as in genetic, genesis, etc.? This would obviate the confusion which is bound to arise and persist if the preoccupied term "genotype" is adhered to. It is such a valuable conception of Professor Johannsen's that it seems worth while to have a permanent and undisputed designation for it.

HENRY FAIRFIELD OSBORN

AMERICAN MUSEUM,
February 7, 1912

SCIENTIFIC BOOKS

Grundzuge der Paläobiologie der Wirbelthiere.

By O. ABEL, Professor of Paleontology in the University of Vienna. Stuttgart, E. Schweizerbart. 1912. Pp. xii + 708, frontispiece and 470 text illustrations.

This extremely interesting and highly important treatise is in effect a text-book of adaptation among the vertebrates past and present. The subject is, as Doctor Abel observes, the most recent development of paleontologic science. Speculations, indeed, on the habits and environment of extinct animals are as old as the first finding of their fossil re-

mains. But the systematic study of the subject, analysis of the adaptive characters of living animals and interpretation of the adaptation of extinct animals, is a development of the last few years. It requires as its groundwork thorough morphologic study of complete skeletons, which until recent years have been very rarely available among fossils.

The subject is a fascinating one—somewhat speculative in the present stage of its development, for the criteria of adaptation are not yet perfectly worked out or thoroughly tested. But it lends to these dry bones a living interest that a systematic treatment lacks, and a faunal or even a phylogenetic treatment imperfectly supplies. Doctor Abel has given particular attention to this phase of paleontology and his work is authoritative, especially in the field of marine adaptations. The subject is clearly presented and well illustrated.

The volume opens with a sketch of the development of paleontologic method. Then follows a discussion of the causes, conditions and processes of fossilization. The principal portion is devoted to the various adaptations of vertebrates, especially of fossil vertebrates as interpreted by modern adaptations, and a full discussion of the criteria of adaptation in external form and in construction of feet, teeth and other parts. A final chapter discusses the relations of paleobiology and phylogeny.

The analyses of the various adaptive types with their parallel and divergent characters are admirably clear and serve to bring together the latest results of studies in *ethology*, as the study of adaptation is called by Dollo. The illustrations are numerous, well chosen and instructive.

The entire volume is surprisingly free from errors of fact—such criticisms as may be made are in matters of interpretation and theory. Doctor Abel is perhaps a little prone at times to accept the theoretical conclusions of others without sufficient critical sifting of the evidence, and here and there one finds difficulties in reconciling conclusions which in truth are based upon mutually exclusive data.

The volume is crowded with novel sugges-

tions and interpretations of adaptation of various extinct races. Most of them will be welcomed and accepted; some may need further consideration; a few seem open to serious criticism. The discussion of the carnassial teeth of carnivora ignores their most essential feature, the shearing adaptation. The hypothesis that the inner digit of the fore foot in amphibia is primarily absent, and its presence in reptilia and mammalia is a "neuerwerbung," will not commend itself to many; nor will the interpretation of the Stegocephalia and Cotylosauria as fossorial adaptations be readily reconciled with the strikingly paddle-like construction of the feet in these animals, especially the former. But these and a few other points are occasional lapses from the normally high standard of thorough and up-to-date information and good judgment. The book will rank as one of the most important and readable contributions to paleontologic literature, and be indispensable to every one who wishes to understand and teach the real meaning of extinct animals and their relations to the world in which they lived.

W. D. MATTHEW

Inheritance in Maize. By E. M. EAST and H. K. HAYES.

This is an interesting and important contribution from the Bussey Institution of Harvard University, which has appeared as Bulletin 167 of the Connecticut Agricultural Experiment Station. It presents a very thorough study from the Mendelian standpoint of a number of characters of the Indian corn plant and their method of transmission. The interest in this study, however, is by no means confined to its connection with the improvement of this, our greatest agricultural crop, for many of the principles involved have a significant bearing upon several of the more general problems of heredity.

The bulletin, embracing as it does so many different considerations, scarcely admits of a summary that would be short and at the same time intelligible. It is the present purpose, therefore, merely to indicate the general plan and scope of the work by mentioning briefly a

few of the many interesting points touched upon.

After a short introduction in which the authors point out the advantages and disadvantages offered by the maize plant as material for study of genetics, the subject is conveniently divided into five parts.

In Part I, is presented the *material and the problem*, and the corn plant, *Zea mays*, is considered in its systematic relationships. Different classifications are considered, but the well-known one of Sturtevant, slightly modified, is finally adopted as being the most practical and convenient. In this connection there is some speculation in regard to the origin of maize based upon the facts brought out in the investigation concerning the transmission of its characters. After reviewing briefly some of the theories proposed by other authors the suggestion is here offered that maize is derived from teosinte or some similar plant. The maize ear represents an evolutionary product derived by progressive meristic variation of the central spike of the lateral tassels of the teosinte. Other changes are to be accounted for in the accession or dropping of characters, the transmission being in accordance with Mendel's principles.

Mention is then made of the work of previous investigators of inheritance in maize. It is interesting to note how very close some of these workers were, in the days of the eighties and nineties, to the rediscovery of Mendel's law, yet failed to recognize its operation in their results. It is also interesting to note that *Zea mays* is the plant that furnished the data which finally did lead to the rediscovery of the law on the part of both de Vries and Correns.

Next follows a catalogue description in detail of each of the twenty-nine ears of corn that formed the parentage of the various hybrid combinations used in this investigation. Experimental methods and precautions are described. Very much of the value of this report depends upon the painstaking care with which the investigation was carried out, as for example, the previous inbreeding of all the stock used, in order to establish purity. An-

other tremendous advantage is gained by going to the trouble of making separate pedigree cultures of the various lines, thus admitting an analysis of results, such as was sometimes impossible in the case of the work of previous investigators in this field.

Part II. deals with *endosperm characters*, and under this subject is taken up first the transmission of starchiness of endosperm. Although the behavior of this character as to dominance and segregation is already known, the matter is made the subject of an unusually thorough and critical study here because of the sharpness and completeness with which starchiness segregates and with the idea of applying this study to some fundamental principles in their connection with Mendelism, such as prepotency and gametic purity. In all the large number of cases examined the behavior in this respect is found to be so regular as to force the conclusion that "the mechanism by which the members of an allelomorphic pair are distributed among the gametes is accurate," and none of the extra explanations offered by some other investigators to account for discrepancies are needed here.

In connection with the transmission of yellow and non-yellow endosperm, an important principle is brought out; namely, that in certain strains of corn yellowness is not a simple unit, but rather is the result of two distinct and independent yellow units or factors operating to give precisely a di-hybrid effect. This is an important observation, in that the same principle may be carried to various other characters supposed to be simple, but which in reality may prove, upon more critical analysis, to be compound, depending upon the operation of a series of units or factors.

The transmission of endosperm colors has been left rather vague by the experiments of previous investigators in this field. Some of the discrepancies in the results of Correns and of Lock with respect to the behavior of purple aleurone colors are now explained by the present investigation; thanks to the separate pedigree culture making possible a more thorough analysis of data. It is found that the

behavior in this regard is not always constant, but varies in different strains or families, apparently depending upon the constitution of the uniting gametes. The conception of certain developer and inhibitor factors serves to explain quite satisfactorily most of these cases, and it is believed that when all of the facts are known, most, if not all, of these discrepancies and contradictions will be similarly explained, and thus will be wiped out some more of the seeming exceptions to the law of Mendel.

Part III. is a discussion of *Xenia* and the observations here are in the main in accord with those of previous investigators. On account of the various effects of dominance in different cases some confusion has arisen concerning this phenomenon. An explanation of these cases is given in connection with which the following law regarding *Xenia* is formulated:

"When two races differ in a single visible endosperm character in which dominance is complete, *Xenia* occurs only when the dominant parent is the male; when they differ in a single visible endosperm character in which dominance is incomplete or in two characters both of which are necessary for the development of the visible difference, *Xenia* occurs when either is the male."

In Part IV. is considered the inheritance of a number of *plant characters*. In the case of the podded kernel the presence of pods is found to be a perfect dominant. In the investigation of pericarp colors a number of different kinds of reds are distinguished. Red in cob color was found to behave as a simple character in the cases examined, but red color in silks appears to be more complex in its inheritance.

A section is devoted to the matter of *physiological transformation of starchiness*, and a study of the crosses between soft starchy and corneous starchy sort brings out the following three facts: "The characters that give the flint or the dent appearance to maize are transmitted as plant characters to the entire ear and not as endosperm characters to the individual seed. They conform to the essen-

tial feature of Mendelism by showing segregation; and they are due to the action of more than one transmissible character."

A discussion of *size characters* is next taken up, including observations on numbers of rows of kernels on ear, height of plant, length of ear and size of seed. Studies of these characters are naturally beset with complications, the results being often obscured by the influence of environmental effects. However, the experiments disclosed segregation with respect to these characters, and the conclusion is therefore drawn that size characters do mendelize. Perhaps the most important point in this connection is the suggestion that in such cases which have heretofore ordinarily been considered as continuous variations, we may actually have to do with a series of Mendelian factors in operation, naturally quite difficultly discernible on account of the complex polyhybrid ratios involved, the absence of dominance, and the obscuring effect of environmental influences.

Part V. contains an account of a number of interesting *abnormalities* which arose among these various cultures. The appearance of several dwarf plants is described, but their significance is rather obscure, since no ratios were obtained. Bifurcated ears transmitted this abnormality as a dominant. In the case of striped foliage arising as though by mutation in some of these strains, the striped plants are considered to be heterozygous.

Aside from the interesting content of the bulletin, the authors are to be congratulated on its general appearance and make up. It is well illustrated by 25 plates of excellent photographic reproductions. The data are well chosen and presented in very convenient arrangement.

L. H. SMITH

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE MOST NORTHERLY SCIENTIFIC INSTITUTION

THE weather observatory recently established by the Norwegian Meteorological Institute at Spitzbergen, 1,100 miles north of Christiania, is the most northerly permanent scientific institution of any kind in the world.

Meteorological data are communicated to the central office by means of wireless telegraphy via Green Harbor. The progress made at the observatory may be watched with interest, as it is hoped that the data there obtained will aid in European weather forecasting. The Norwegian project is separate and distinct from the German expedition, headed by Drs. Wagner and Rempp, which is now carrying on research in aerology and geophysics in Spitzbergen.

THE ANNUAL REPORT OF LINDENBERG OBSERVATORY

THE report of the Royal Prussian Aeronautical Observatory at Lindenberg for the year 1910 has recently appeared. As has been the case during several years preceding, upper-air investigations were conducted daily, without a single exception, throughout the year. The meteorograph was elevated by means of kites 459 times, and by means of captive balloons 211 times, the average height with the former method being 9,866 feet, and with the latter 9,898 feet, both of which are higher than the corresponding averages for any earlier year. Of 29 registering balloons sent up 27 were recovered, and the average height attained was 49,028 feet (9.3 miles). On August 20 the greatest height yet reached at Lindenberg was recorded, the barograph indicating a height of 82,138 feet (15.6 miles). 177 pilot balloons carrying no recording instruments were also sent up during the year, data of wind velocity and direction aloft being obtained from these ascensions. In addition to the aerological data, which are printed in detail, the report contains five papers prepared by various members of the observatory staff.

WATER VAPOR IN THE ATMOSPHERE

In observations with a telescope, bolometer or pyrheliometer the approximate amount of water vapor in the atmosphere is an important factor. The determination of this amount by spectroscopic methods is not very satisfactory. In order to simplify the evaluation of this factor Professor W. J. Humphreys has examined the data obtained in 74 balloon flights made on cloudless days. Conditions on

cloudless days alone were considered, since in practical work a knowledge of the moisture content is needed only upon such days. The data used pertain to Europe alone, but presumably are fairly representative of conditions everywhere, since they cover the observations of several years and were obtained at many different places. Though the amount and the distribution of the water vapor in the atmosphere varies greatly from day to day and from place to place, it is interesting to learn that there is a tendency toward a maximum of humidity just above one of the levels of maximum cloudiness, the cumulus level. While there were no clouds at this or any other level at the times of observation, the water vapor was relatively abundant there, and, though not dense enough to produce a cloud, was made manifest by the readings of the hygrometer. Among the conclusions stated by Professor Humphreys (*Bulletin of the Mount Weather Observatory*, Vol. 4, Part 3) are the following:

The amount of water vapor per unit volume decreases with elevation in an approximate geometric ratio, and the thickness of the water layer that would result from a condensation of all the water vapor in the atmosphere above any given level, whatever the season, so long as cloudless days are used, may be approximately expressed by the equation, $d=2w$, in which d is the depth of the water layer in millimeters and w the weight in grams of the water vapor per cubic meter at the given level or place of observation. An alternate, and probably equally good expression, is, $d=2e$, in which d , as before, is the depth of the water layer in millimeters, and e the partial pressure of the water vapor in millimeters of mercury.

Professor J. Hann had previously concluded, from observations made upon all kinds of days, regardless of cloud, that $d=2.3e$, or about 15 per cent. greater than the value now found for clear days.

NEW BOOKS

AMONG the books which have recently appeared are: (1) "Thermodynamik der Atmosphäre," by Dr. Alfred Wegener. Leipzig, J. A. Barth, 1911. 8°. 331 pp. (2) "Aeronautische Meteorologie," Teil II., by Dr.

Franz Linke. Frankfurt a. M., F. B. Aufarth, 1911. 8°. 126 pp. (3) "Climatic Control," by L. C. W. Bonacina. London, Adam and Charles Black, 1911. 8°. 167 pp. (4) "Studie über Licht und Luft des Hochgebirges," by Dr. C. Dorno. Braunschweig, F. Vieweg & Sohn, 1911. 8°. 153 pp. (5) "Dynamic Meteorology and Hydrography," Part II., Kinematics, by V. Bjerknes and different collaborators. Washington, Carnegie Institution of Washington, 1911. 4°. 175 pp. (6) "The Clouds and Fogs of San Francisco," by Alexander McAdie. San Francisco, A. M. Robertson, 1912. 8°. 106 pp.

EXCESSIVE PRECIPITATION

DURING the month of July last, Luzon, the largest of the Philippine Islands, was visited by three typhoons accompanied by rains which are among the heaviest on record anywhere upon the earth. The precipitation accompanying the first typhoon was greatest at Baguio, the summer capital and official health resort of the islands. The rainfall there, as registered by an automatic gauge of standard design, was as follows: 14th, 34.64 inches; 15th, 28.88 inches; 16th, 16.73 inches; 17th, 7.89 inches—a total of 88.14 inches in four days. (The mean annual rainfall for New York City is 45 inches.) The second storm was severest at Bolinao, where 26.69 inches of rain fell during July 20 to 27, inclusive. With the third typhoon, that of July 30 to August 2, inclusive, 23.80 inches fell at Candon, while Baguio received an additional 20.14 inches. Naturally the floods following these unprecedented downpours did enormous damage. The \$2,000,000 military road stretching for 52 miles over the mountains between Dagupan and Baguio was seriously damaged. It had previously been forecasted that this road, regarded as one of the engineering feats of the islands, would remain "until the Pyramids crumbled." The rainfall at Baguio during the four consecutive days of the first storm has rarely been exceeded anywhere in recent times. The only records of greater amounts for a similar period are: (1) 101.84 inches at Cherrapunji, India, June 12 to 15,

inclusive, 1876, and (2) 96.50 inches at Silver Hill, Jamaica, in November, 1909. The Indian station, located upon the Himalayan slopes, near the Bay of Bengal, remains the wettest spot on the globe. It is reported that during one month, August, the rainfall measured 384 inches, and it is believed that the annual precipitation is over 600 inches.

A NEW WEATHER SIGNAL

SINCE December 1 a new marine signal consisting of a red pennant has been displayed by the United States Weather Bureau to signify the approach of high winds which would not justify the issue of the regular storm warning. It is known as the "small craft warning," as it is designed especially for the owners of fishing, towing, motor and yachting craft. The pennant is flown from the officially designated flagstaffs on the Atlantic, Pacific and Gulf coasts, as well as along the borders of the Great Lakes. Judging from recent press reports the innovation is proving of value to those for whom it was intended.

CONCERNING AVIATION FATALITIES

AMONG the suggestions which have been offered to explain various fatal accidents in aviation recently is that which one aviator describes as "ethereal asphyxia, a dreadful something which lurks in the upper air and creeps irresistibly upon the senses of the aviator, lulling him into a dreamy unconsciousness." He declared that it was not due to rarefied atmosphere, as there was no stifling, choking or pain in the ear-drums, such as often results from decreased pressure. The falsity of the explanation is apparent to any one who considers the matter, for aeronauts have, for more than a century, ascended to far greater heights than the aeroplane has yet reached, and no "mysterious gas" has been reported. Soundings of the free air have established the fact that up to the greatest height attained by an aeroplane, about two miles, the composition of the atmosphere is sensibly the same as at the ground. However, some of the fatalities occurring can not be explained by mechanical defects, gusts of

wind, or "air-holes." Might not the "ethereal asphyxia" be similar to the drowsiness experienced by certain people in windy weather? Persons who have climbed to the summits of high hills or mountains often express a desire to lie down and sleep. Moreover, the cold aloft is another factor to be considered. One traveling in a balloon experiences a perfect calm about him and thus is not greatly affected by the low temperatures. But every one who has sat in the front seat of a rapidly moving automobile on which there was no wind-shield can readily imagine how chilling must be the air encountered by an aviator traveling against the wind. Even in mid-summer temperatures below freezing are met at a height of two miles, and such air, brushing past the aviator at a rate of a mile a minute, might soon cause temporary paralysis of the limbs, resulting in a loss of control of the craft. The heaviest clothing yet worn by an aviator could hardly give him the protection needed. Accelerated heart-action, nervous tension, fatigue and other factors doubtless contribute to the aviator's distress. The problem is not wholly a meteorological one.

ANDREW H. PALMER

BLUE HILL OBSERVATORY,

February 1, 1912

SPECIAL ARTICLES

ON THE ORIGIN OF AN ALBINO RACE OF DEER-MOUSE

THE first case of Mendelian inheritance shown to exist among animals was that of total albinism in mice. In this condition the fur is snow-white and the eyes are pink, they like the fur being entirely devoid of skin-pigment. For the pink color of the eyes is due to the blood seen through the transparent eye; it disappears at death.

The ordinary white mouse is an albino variety of the common house mouse, with which it crosses readily. Cross-bred offspring (F_1) are never white, but like the wild parent in color. But in the next generation (F_2), part of the offspring are albinos. On the average one fourth are albinos, and these breed true in accordance with Mendel's law.

The time and place of origin of the common white mouse is entirely unknown; the same is true of nearly all distinct varieties of animals either domesticated or wild. Peculiar interest therefore attaches to a case in which an albino race has arisen from a wild species. Such a case I will now briefly describe.

The native field mouse of North America is known by several different common names, such as deer mouse, field mouse, white-footed mouse and wood mouse. Systematic zoologists at the present time give it the generic name *Peromyscus*. The most recent and exhaustive study of this genus is that of Osgood¹ (1909), who, after examining over 27,000 specimens from all the great collections of America and all other available sources, "conservatively" recognizes 157 distinct species and subspecies.

In the light of this exhaustive study it seems probable that *Peromyscus* is the most abundant and the most widely distributed of North American mammals, as well as one of the most carefully studied from the systematic standpoint. Nevertheless an albino specimen has never up to the present time been reported, which would seem to indicate that its occurrence is very rare.

In the fall of 1909, Mr. K. S. Clark caught in the woods near St. Johns, Clinton County, Michigan, a pure white albino *Peromyscus*. This he kept alive for some weeks and then delivered it to Professor Walter B. Barrows, of the Michigan Agricultural College, where Mr. Clark was a student. Fortunately neither Mr. Clark nor Professor Barrows obeyed the common impulse straightway to make a museum specimen of the rare individual. They tended this unique animal with great care. Later through the kindly interest of Professor W. M. Barrows, of Ohio State University, who was engaged with me in breeding experiments with *Peromyscus*, the albino was sent to me. I received it in Feb-

ruary, 1911, and kept it alive at my house or at the Bussey Institution until January 29, 1912, when it died probably from extreme cold.

In March, 1911, Mr. Clark trapped a dozen other *Peromyscus* near the place where he had caught the albino the previous fall, and sent these to me. All were normal in appearance and referable to *Peromyscus leucopus novboracensis* Fischer, as described by Osgood. Two of the females were successfully mated with the albino which proved to be a male. During the summer and fall of 1911 they produced 6 litters of young including 28 individuals, all normal in appearance like the mothers. One of the daughters was mated with the albino father in October, 1911. On November 21 she bore a litter of three young, an albino and two ordinary young, but all were eaten the following night. Three weeks later she bore a litter of four young, two being albinos and two normal. The albinos were successfully reared, but no more young have since been born, and as this species does not breed in winter it is not probable that more will be obtained for some months.

The behavior of the albino variation thus far is that of a simple Mendelian recessive, as in house mice, guinea-pigs, rabbits and rats. The experiment has not yet progressed far enough to show whether the albino variation has been attended by variation in any other pigment factor, and so its continuation is awaited with interest. In the other rodents mentioned we have not only albino varieties, but also black ones (lacking a ticking or "agouti" factor), in all except rats yellow ones (with a reduced amount of black), and in mice and guinea-pigs brown ones (lacking black entirely). As nothing is known concerning the origin of these variations, it is uncertain whether they arose simultaneously with the albino variation, or as a consequence of it, or wholly independently of it. As, however, we find the inheritance of these variations to be wholly independent of the inheritance of albinism, it seems probable that in origin also these variations were independent. A case in which observation along these lines is possible is heartily welcomed.

¹ Osgood, Wilfred H., "Revision of the Mice of the American Genus *Peromyscus*," Publication of U. S. Department of Agriculture, Bureau of Biological Survey, N. A. Fauna, No. 28, 285 pp., 8 pls., Washington, 1909.

Men who make a business of producing plant novelties, Burbank, for example, are delighted with the slightest indication of sporting, because they consider that, the "stability of the type" having been disturbed, other variations are likely to follow.

Whether there is any basis of fact for this idea cases like that here described may tend to show, if carefully followed up. If the supposed phenomenon is found to be a real one and an initial color variation is frequently followed by others, then it will remain to discover an explanation, since "instability of type" can scarcely be regarded as an explanation, but only a figurative statement, of a phenomenon observed.

Studies of the inheritance of albinism, as already stated, show it to be independent in transmission of the several factors which determine the particular character of the pigmentation, as gray, black, yellow, etc. For in crosses with colored varieties, albinos actually do transmit to their offspring particular qualities of pigmentation, as gray, black, yellow, etc. It is assumed, therefore, that in the albino variation something has been lost from the organism which is indispensable to the production of pigment, though it has nothing to do with controlling the particular sort of pigment which the organism can form. Albinos, therefore, can be produced of as many different sorts as regards their breeding capacity, as are the visibly different pigmented sorts. Each pigmented sort finds its counterpart among albinos, though all these albinos may look alike. A study of the progeny of an albino through two generations will serve to show with what particular colored variety it corresponds. Such a study has not yet been completed for the albino *Peromyscus*.

The albino variation, being a *loss* variation and recessive in nature, must have existed in both the gametes (the egg and the sperm) which produced the individual captured by Mr. Clark. Both the parents of that individual, accordingly, transmitted albinism and probably produced other albino young, if they had more than a single litter of offspring. But the survival of albino offspring in the wild

state would be exceedingly doubtful because of their conspicuousness and their defective vision. Yet the heterozygous brothers and sisters of the albino sports should themselves be at no disadvantage in the struggle for existence and should produce about 25 per cent. of albino young. Therefore we should not be surprised if the sporadic occurrence of albinism should continue in a locality where it has once made its appearance, as in Clinton County, Michigan. The naturalists of that region would perform a service to science by looking for and reporting future occurrences of albinism in field mice there.

In conclusion I wish to express my gratitude to Professor Barrows (father and son) for entrusting to me the experimental study of this interesting variation.

W. E. CASTLE

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February 7, 1912

ORIGIN OF THE SEDIMENTS AND COLORING MATTER OF THE RED BEDS OF OKLAHOMA¹

SINCE the origin of the sediments and the red coloration of the Oklahoma red beds has long been the object of more than ordinary curiosity, it may not be out of place to briefly outline some of the results of a recent study of these deposits.

Previous workers have made known the fact that the light-colored sediments of the lower Permian rocks of Kansas become red in Oklahoma, and that the similar light-colored Albany beds of Texas redden on approaching Oklahoma. In the Texas reports Cummins hinted that a lateral transition of the Albany beds into the red rocks of the Wichita formation might not be impossible. Later he worked out this transition in detail.² Gould and

¹Published with the permission of the director of the Oklahoma Geological Survey.

²The leading recent articles bearing upon this subject are: Cummins, *Trans. Tex. Acad. Sci.*, for 1897, pp. 93-98. Gould, *Kans. Univ. Quart.*, pp. 175-177, 1900; *Amer. Jour. Sci.*, XL, pp. 185-190, 1900; *Trans. Kans. Acad. Sci.*, XVII, pp. 179-181, 1901. Adams, *Amer. Jour. Sci.*, XII, pp.

Adams first described the transition of the light-colored sediments of Kansas into the red deposits of Oklahoma and Adams made a reconnaissance in Texas. Later, Kirk traced the Wreford limestone into a red sandstone in Oklahoma. Beede suggested that the sediments of the red beds were derived from the Arbuckle-Wichita Mountain region, and Gordon made further studies of the Texas region.

During the past summer the attempt was made to take up the study of this transition in somewhat greater detail in order to discover more fully its nature and significance. The horizons of the rocks lying between the Neva limestone and the Wreford limestone, as represented in Kansas, and a part of the way, the Fort Riley limestone were studied. A trip to the Wichita Mountains was made to study the relation of the red beds to the Permian conglomerates. With the exception of a single reference this paper deals with the strata of the beds studied.

In tracing the limestones and shales of the basal Permian beds of Kansas southward into Oklahoma the relationship of the light-colored sediments to the red sandstones, red shales and red limestones of Oklahoma is clearly revealed. It is shown that some of the heavier ledges of limestone first become sandy along their outcrops in patches a few rods across. Farther south the sandstone areas increase in size until the limestone appears only in local areas in the sandstones and is finally wanting. Traced farther southward, the sandstones become deep red or brown with local areas of white. The decimation of the fauna sets in as the limestones diminish and the remains of life are not found far beyond the limits of the limestones. The shales become red very much farther north than do the sandstones, and are frequently more deeply colored. Some of the lower limestones become red before they change into sandstones. The sandstone ledges continue for some distance southward

as rather even, uniform beds, but farther on they are found to thicken and thin in a somewhat systematic manner.

Several ledges of sandstone frequently occur in a single section and where one of these ledges is found thickened the others are apt to be thicker than normal. Likewise they are all found to be thin over certain areas. The regions of thickening and thinning were found to be parallel belts lying north and south at right angles to the major drainage lines. Two of these belts together with an intervening region about eight miles across were studied. The sandstones thicken at the expense of the shales, sometimes eliminating them. In one instance a thin limestone was traced southwest into one of these zones. A sandstone twenty feet or more beneath the limestone thickens and rises above the limestone and practically unites with the sandstone some distance above it. The limestone seems to die out a few feet from the sandstone, but farther west the latter shrinks to its normal thickness and the limestone is present in its proper position with its usual characteristics.

In these zones of thickening which are frequently several miles wide, the sandstones are very irregularly cross-bedded and frequently ripple-marked, while the thickening is uneven. It would seem that these zones are opposite the mouths of streams which brought sediment into the sea, where the coarser materials were carried farther from the shore than opposite the inter-stream spaces. The irregular thickening of the individual beds may be due to current work, wave action and heaping into local dunes by the wind, though the action of the last factor is uncertain. The irregular bedding and ripple marks indicate a sort of littoral or very shoal condition for the deposition of the sandstones and shales.

As this interesting transition of sediments is traced still farther southward, we find, before reaching the latitude of Shawnee, that the sandstones become more abundant over the whole area, more lenticular, more irregularly cross-bedded and imperfectly lithified. In a single railroad cutting a thick lens of

383-386, 1901; *SCIENCE*, XV., pp. 545-546; XVI., p. 1029, 1902; *Bull. Geol. Soc. Amer.*, pp. 191-200, 1903. Beede, *Jour. Geol.*, XVII., pp. 710-729, 1909. Gordon, *Jour. Geol.*, XIX., pp. 110-125. Kirk, Third Bienn. Rep. Okla. (Terr.) Geol. Surv.

sandstone may fade into a soft sandy clay shale with the same bedding and structure as the stone itself and change back into a sandstone a few rods away. Most of the sandstones are so incoherent when freshly quarried that pieces two or three inches in diameter crush readily under foot. In many of the wells of the region the water is obtained in "quicksand." Most of the shales contain much fine sand and offer little resistance to weathering.

At their southern limit these red sandstones and shales are found to dovetail into the Permian conglomerates on the northern side of the Arbuckle mountains, while similar conditions obtain among the higher beds farther west where similar conglomerates occur on the flanks of the Wichita mountains. These conglomerates are largely composed of the fragments of the pre-Carboniferous limestones aggregating 8,000 or 10,000 feet in thickness flanking the mountains and at one time covering them. The solution of these limestones produces a red clay wherever the insoluble residue happens to remain undisturbed below the vegetable mold, and the disintegrating limestone conglomerates produce a more or less sandy red clay indistinguishable from some of the red bed sediments. Thus it seems not improbable that much of the material of the red beds in the region studied was derived from these thick limestones.

Considering all these phenomena, it is apparent that the transition of deposits from the Arbuckle mountains to the Kansas line is such as would be expected in passing from the mountains out into a shallow epicontinental sea.

That the solution of limestone produces red residual clays is well known. It is exhibited in the residual soils and clays of the limestone regions of the unglaciated part of the Mississippi Valley, Cuba, southern Europe and elsewhere. The clays thus derived and their coloring matter—the red oxides of iron—are minutely divided and when in suspension settle slowly, but little movement of the water being sufficient to keep them in suspension. This characteristic adapts them to

long transportation. The great thickness of the Arbuckle and associated limestones, and their former extent, over thousands of square miles of country where they are now removed or represented only by their upturned edges surrounding the mountains, seem to furnish an ample source of the coloring matter and a considerable amount of the clays of these lower Oklahoma red beds. The Gabbros, red granites and red porphyries of the Arbuckle-Wichita region also contributed their share of sediment to the red beds.

From these observations it would appear that the sediments of the lower red beds of Oklahoma were derived largely from the Arbuckle-Wichita Permian land mass and the coloring matter mainly from the solution of the limestones known to have been removed from it. It also seems probable that the sediments of the region studied, especially those some distance from the mountains, were deposited in very shallow turbulent water, or vast tidal beaches, inimical to life of all kinds, since they are void of fossils or even carbonaceous matter.

J. W. BEEDE

THE ENTOMOLOGICAL SOCIETY OF AMERICA

THE sixth annual meeting of the Entomological Society of America was held at Washington, D. C., Tuesday and Wednesday, December 26 and 27, in room 376 of the new U. S. National Museum building. The following papers were presented:

HERBERT OSBORN: *Faunistic Studies in Entomology*.

The need of an extended and accurate record of insect fauna is urged, with statement of instances where such data have been much needed. Attention is called to the possibilities for widely scattered workers to assist in such studies and the desirability of some connected plan by which to encourage and bring together the results of such studies. A suggestion is made that the society appoint a permanent committee on faunistics, the duty of which will be to devise means for the encouragement of faunistic studies and to bring together the correlated results in this line with reports to the society as to methods proposed and the results secured.

E. P. FELT: *Numerals as Aids in Classification*.

The habitual use of numbers in catalogues indicates utility. A modified system of decimal notation is adapted to the needs of naturalists, while additions require little change. A general agreement upon the numbers for the major zoological division is suggested prior to the application of the system by cataloguers and other general workers.

E. S. TUCKER: *Studies of Insects Bred and Collected from the American Mistletoe*. Presented by Andrew Rutherford.

By the name of "American mistletoe," the species *Phoradendron flavescens* Nuttall and its several varieties is meant. Two snout-beetles belonging to the same group as the cotton-boll weevil were bred from terminal enlargements of the stem. From the larvæ of one of these beetles five hymenopterous parasites were bred, all of which attack the larvæ of the cotton boll-weevil. About sixty species in all were obtained.

H. C. SEVERIN: *The Influence of Temperature on the Moulting of the Walking-stick, Diaphanera femorata*. Read by title.

R. MATHESON and C. R. CROSBY: *Notes on Aquatic Hymenoptera*. Illustrated. Presented by C. R. Crosby.

Three species of aquatic hymenopterous egg parasites have been reared at Ithaca, N. Y.: (1) a trichogrammid from the eggs of a damselfly (*Ischnura* sp.); (2) a prototrupid from the eggs of a water strider (*Gerris* sp.); (3) a mymarid from the eggs of a back swimmer (*Notonecta* sp.). All of these forms are able to swim actively under water by means of their wings. They are also able to use their wings for flight in the air.

ANNA H. MORGAN: *Photographs Illustrating the Life Histories of May-flies*. Illustrated.

Photographs were shown which illustrated the life history and biology of about twenty-five May-flies. Both nymphs and adults were photographed alive; the nymphs in a solution of chlorotone, the adults without anæsthetic. Nymphs representing the main biological groups were shown and their habitat described. Imagoes and subimagos of certain genera were shown and their structure and characteristic postures noted.

H. Y. TSOU: *The Chinese Wax-scale, Ericerus pe-la*. Illustrated.

One of the most beneficial insects of the family Coccidæ has been domesticated by the ancients of the Chinese people for the wax which it produces. This paper consists of (a) correction of errors of

European translations from Chinese works; (b) additional statements on the life history of the insect; (c) method of propagating this insect; (d) division of labor in carrying on this industry among the people of different localities, so that the eggs of the insect are produced in the northern district and the wax in the southern district; (e) importance of this industry; and (f) use of the wax.

A. D. MACGILLIVRAY: *The Lacinia in the Maxilla of the Hymenoptera*. Illustrated.

The Maxilla of *Macroxyela*, one of the most generalized of Hymenoptera, has the lacinia well developed. The lacinia among the wasps is a well-marked, triangular lobe attached to the distal and mesal end of the stipes. The maxilla of the Apoidea is greatly elongated for sucking, the galea enlarged and the lacinia reduced. The lacinia is a rounded lobe fringed with setæ and occupying the same position as it does in *Vespa*. It is not wanting or united with the galea in the honey-bee, as is usually stated in text-books and works upon apiculture.

LUCY WRIGHT SMITH: *Glycogen in Insects, especially in the Nervous System and the Eyes*. Illustrated.

In a heterogeneous lot of insects, including representatives of seven orders, glycogen has been found: (1) in immature and adult stages (a) in the crystalline cells of compound eyes, (b) in the crystalline and retinal cells of simple eyes, (c) in the neurilemma; (2) in immature stages only, (a) in the cells of ganglia in all parts of the body. No glycogen has been found in nerve fibers.

J. A. NELSON: *Note on an Abnormal Queen Bee*. Illustrated.

This queen was originally sent from Grand Bay, B. W. I. When received she was alive and quite active. It was planned to introduce her into a hive to test her fertility, but she died by accident before this was done. The dead queen appeared normal in structure with the exception of the abdomen, which was ovoid in shape, instead of conical as in the normal queen; it was also flexed strongly ventrad at the apex, which had consequently a blunt appearance, like that of the abdomen of the drone. The sternites of the 5th and 6th abdominal segments were unusually broad and somewhat asymmetrical, as was also the sternite of the 4th segment. The sternite of the 7th segment was the most modified of all, being greatly shortened in the longitudinal axis, and almost concealed by the sternite of the preceding segment.

The notch on its posterior border was abnormally broad and deep. The sting had a slight kink midway of its length.

The internal organs were apparently normal with the exception of the genital organs. The left ovary and oviduct were entirely wanting. The right oviduct and ovary were present, but the latter appeared to possess only a single egg tube. The spermatheca was empty. The bursa copulatrix was also shortened in the longitudinal axis, so that the external openings of the spermatheca and the poison glands were brought close together. No characters suggestive of hermaphroditism were found. The cause of the abnormalities is unknown.

J. CHESTER BRADLEY: *The Designation of the Venation of the Hymenopterous Wing*. Illustrated.

In the higher Hymenoptera, owing to certain remarkable conditions that prevail, the full application of the Comstock-Needham system of venation becomes a very complex matter. This is especially true in the case of the hind wings. By certain simple abbreviations this complexity is avoided, and the system becomes quite conveniently usable for taxonomic purposes.

ANN H. MORGAN: *Homologies in the Wing-veins of May-flies*. Illustrated.

The main tracheæ of May-flies precede and constantly mark the course of the main veins. The costal and subcostal tracheæ are simple, as are the veins which follow them. The radial trachea (except in one form) and the vein which follows it are unbranched. The radial sector is very probably present in May-flies, but in an unusual position between the veins M_1 and M_2 . It is detached from radius as in the dragon-flies and stranded upon M_1 . The medial vein has its characteristic four branches. This interpretation involves important changes in the nomenclature of radius and media.

A. D. MACGILLIVRAY: *The Pupal Wings of Hepialus thule*. Illustrated.

The adult wings of *Hepialus* are very similar to the hypothetical type of Comstock and Needham. The pupal wings show several features wanting in the adult wing. There is a two-branched subcosta, the first branch of subcosta disappearing and the subcosta of the Lepidoptera is therefore Sc_{2+3} . The radial and medial tracheæ enter the wing through the same vein, the media together with a cross-vein forming the areolus between radius and cubitus. The presence of an areolus has not been reported in the Lepidoptera hitherto.

J. CHESTER BRADLEY: *The Wing Venation of Chalcid Flies*. Illustrated.

The hymenopterous family Chalcididae present a uniform excessive reduction in the number of their wing veins which is approached elsewhere in the Hymenoptera only by certain Proctotrypidæ and Evaniidæ. This depletion is the result of a degenerative tendency that is manifest wherever there is considerable reduction in the size of the wasp. It is of interest to ascertain with what veins of other Hymenoptera the vein remnants in the Chalcid wing are homologous.

The so-called marginal vein is in reality the elongated stigma, the "post-marginal" is r and R_1 and usually bears on its anterior margin a spur of the base of R_2 .

Leucospis is our most generalized group of Chalcididae so far as its wings are concerned. The wings of Chalcididae show a close relation to those of Cynipidæ, through *Leucospis* in the one group and *Ibalia* in the other.

F. M. WEBSTER: *Our Present Educational System in Relation to the Training of Economic Entomologists*.

The demand for trained men capable of engaging in entomological work has increased greatly, but the graduates of the colleges generally are not equipped for such work and must have a special training of one to two years before they are available. The author wishes to emphasize the necessity for training in related sciences, in modern languages, and especially in field observation in entomology. The student intending to be an entomologist should begin in his first year with field observations and should be required to gather his own material for study. It would be especially desirable that students training for entomological work should have an experience at least during their vacations in work in some experiment station, and this sort of work should very properly be given credit in the college or university as part of the requirements leading to a degree.

C. W. JOHNSON: *The Use of Color in Designating Types and Varieties*.

Colored labels for types is being carried to an extreme. At the last meeting of the Cambridge Entomological Club one of our members who makes a specialty of printing labels for entomologists, asked me "what is an allotype, a homotype, a metatype, an autotype and a topotype, and why don't they use the same color for the same kind of a type? One wants his paratype on light

green, another on pink and a third on brown. Why I can't get enough colors to go around." An energetic collector with time and money at his disposal can make some sort of type out of seventy-five per cent. of his species. These variation types may have some value, but they can not always be depended upon. A great number of colors used indiscriminately is very confusing, for there are equally important features that might be designated by color, aside from manufactured types. Colors could be used to advantage to indicate abnormalities, especially to-day when the experimental biologist is after data as to the number and kinds of abnormalities that occur in specimens in nature. Such specimens are completely overlooked unless they are marked in some way. Not more than two colors should be used for types: red for the primary, and green for supplementary types. Then another color, yellow, for instance, could be used for abnormalities.

HERBERT OSBORN: *A Problem in the Flight of Insects.*

Insect flight has been explained continuously by the movements of the wings vertically, the rigid anterior border with flexible hinder portion of the wing serving to so relate itself to the atmosphere as to furnish a forward movement. While this explains readily the forward progression, it does not in itself explain the hovering or the backward flight of many insects which is a matter of common observation. Numerous instances cited illustrate this feature. The explanation suggested for this movement is that the wings are rotated forward until the flexible under-portion of the wing reacts upon the atmosphere in such manner as to maintain the insect in a stationary attitude or even to propel it in a backward direction. Such rotation may be seen to be amply provided for in the structure of wings and the close observation of insects in hovering indicates the forward rotation.

E. P. FELT: *The Biology of Miastor and Oligarces.*

The widely distributed *Miastor* larvæ reproduce by pedogenesis in the moist, decaying bark of various trees during fall and spring, midges appearing from June till August. A larval generation occupies three to three and a half weeks. *Oligarces* is less common than *Miastor*. Both are subject to attack by a number of natural enemies.

LEONARD HASEMAN: *Entomological Work in Missouri.*

Since the early masterly work of Dr. C. V. Riley the entomological needs of Missouri have not been

properly served. Every line of entomological work is open for study. This department is investigating the more urgent insect problems of Missouri, though it is much handicapped by lack of assistance. The work connected with the instruction, station, nursery inspection and duties of state entomologist is more than the present staff can properly handle.

W. L. W. FIELD: *Hybrid Butterflies of the Genus Basilarchia.*

Since the Boston meeting two years ago, considerable progress has been made in the experiments with the supposedly hybrid *Basilarchias*, *B. proserpina* Edw. and *B. arthechippus* Scud. Their hybrid nature has now been proved by breeding experiments. The data obtained also support the conclusions drawn from earlier experiments, to the effect that in *proserpina* the black of *astyanax* is incompletely but uniformly dominant over the white-banded condition of *arthemis*.

O. A. JOHANNSEN: *Cocoon Making of Bucculatrix canadensisella.* Read by title.

J. G. NEEDHAM: *Some Adaptive Features of Myrmeleonid Venation.* Read by title.

E. H. STRICKLAND: *The Pezomachini of North America.* Read by title.

P. P. CALVERT: *Seasonal Collecting in Costa Rica.* Read by title.

Z. P. METCALF: *Homologies of the Wing Veins of Homoptera Auchenorrhynchi.* Read by title.

The following annual public address was given at the Cosmos Club, Wednesday evening, December 27:

J. H. COMSTOCK: *The Evolution of the Webs of Spiders.* Illustrated.

It is probable that the production of silk by spiders was not primarily evolved for the making of webs for capturing prey. The representatives of many families do not spin webs; and there is no reason to believe that these non-web-making families have descended from web-making forms. All spiders use silk in caring for their eggs; and it is probable that this was the primary use of silk in this group of animals.

Spiders having acquired silk for the protection of their eggs have utilized it for other purposes, of which the making of webs for capturing prey is but one, and probably not the next one in the sequence of the different uses of this substance. The acquiring of the habit of spinning a drag-line, the thread which most spiders spin wherever they go, doubtless preceded the making of webs. A spider spinning a drag-line would make a web if

by chance it moved about in a limited space as in some nook in which it had taken up its abode. In such a web insects would be trapped, and thus might arise the habit of building webs for the purpose of trapping insects. Many spiders spin simple irregular webs composed entirely of the drag-line silk. From this simple type was traced series of specializations leading to the different types of complicated webs. In the making of some of these several different kinds of silk are used.

The following officers were elected for the year 1912:

President—Stephen A. Forbes.

First Vice-president—A. D. Hopkins.

Second Vice-president—C. P. Gillette.

Secretary-Treasurer—Alex. D. MacGillivray.

Additional Members of Executive Committee:

J. H. Comstock, J. B. Smith, Henry Skinner, Herbert Osborn, E. D. Ball, P. P. Calvert.

Member of Committee on Nomenclature—H. T. Fernald.

The society adjourned to meet with the American Association for the Advancement of Science at Cleveland, Ohio.

ALEX. D. MACGILLIVRAY,
Secretary-Treasurer

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

THE meeting of the Academy of Science of St. Louis was held at the Academy Building, Monday evening, January 15, 1912, President Engler in the chair. Dr. Arthur E. Ewing presented an illustrated account of *Sanninoidea exitiosa* (Say) and *Sanninoidea opalescens* (Hy. Edwards).

After describing the varieties of the *S. exitiosa* and the difference between them and the *S. opalescens*, giving the history of the insects and Beutenmüller's classification, examples were exhibited of the eggs on the bark of the tree, on the gum from the base of the tree, on leaves from the lower limbs of trees, and one on a trumpet vine leaf that grew a foot from the base of a tree, all of which were observed as they were laid and immediately collected, the collection having been made at the Mountainboro orchard, Mountainboro, Alabama, and at Gadsden, Alabama, between the first and the fifth of September, 1911. The exit of the larvæ from these eggs was observed to be from seven to nine days, the time of the one laid on the trumpet vine was eight days.

For four successive seasons the life period of

the insect had been carefully noted at Mountainboro, and it was found to confirm for northern Alabama the observations of Porter, Starnes and Sherman for Georgia and North Carolina, and shows that in the Southern Allegheny peach belt pupation begins about the first of August and the moth appears the last week in the same month. In 1908, August 4, as many full-grown borers were captured in this orchard of 15,000 trees as there were cocoons, the total number being 1,100; August 7, 300 cocoons were captured and as many borers destroyed. The same conditions obtained during the first week of August, 1909. In 1910 the investigation was made later and resulted in the finding of 8,500 cocoons between the 20th and the 24th of August and very few borers. Two hundred of the cocoons were placed in a wire cage on a southern covered porch. From these 25 moths emerged previous to September 5, 46 between the 5th and the 8th inclusive, 29 between the 9th and the 13th, and after this only two, one male the 16th and another the 21st. The remainder failed to develop.

Observations on the moths in the cage were that their activity depends greatly upon the temperature; with it below 70° F. they are very quiet, and very active when it is above 80° F. At night they sleep with their antennæ spread rather wide, some with the wings moderately spread, usually, however, with the wings near the body as when at rest, and the male with the tip of the abdomen strongly turned upward. When awake and alert the antennæ were erect and near together as if indicating the facial expression of the insect. At night they took no notice of an electric light right above them when it was turned on and off. Thus caged they lived only three or four days.

The 28th of August, 1911, fifty infested trees were examined. From the half of the cocoons the moths had escaped. During the examination only one borer was found which had not yet begun its cocoon. Throughout the orchard the moths were numerous, and in greater numbers from the 1st to the 5th of September. On September 13 only one moth was found, although a careful outlook was kept during the middle of the day, the time when the imago is most active.

An exhibition was made of the larvæ at numerous ages, from the emergence from the egg to the time of spinning the cocoon, together with an example of their destructive work on the tree, and numerous mounted examples of the male and female moth of the *S. exitiosa* type.

Also a cocoon was shown filled with the larvæ

of *Bracon mellitor* (Say), and others filled with the cocoons of this ichneumon, the parasite having been found in from one to two per cent. of the *S. exitiosa* cocoons examined.

Particular stress was laid upon the fact that only black and white drawings of the insects were given in the various state and national bulletins which were distributed throughout the country for the instruction of the orchardist, and lantern slides were shown from the plates of Beutenmüller in which there were at least 75 other examples of *Sesia*, which in black and white would readily be confused with this one by the laity. To be of any real value to the people all government bulletins dealing with insects should contain exact colored plates of the insect described in order to be intelligible to those not familiar with entomology. As an example, the owners and the foreman of the Mountainboro orchard did not know the *S. exitiosa* until they saw it emerge from the cocoon, although all of them had carefully read all the important government bulletins on the subject, particularly those of Slingerland, Marlatt and Starnes, and they had owned and cared for the orchard for more than ten years. As the moth flies only in mid-day, it was unquestionably often seen by them without being recognized.

GEORGE T. MOORE,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 455th regular meeting of the society was held October 24, in the new National Museum. The first paper read was by Mr. J. Mooney, on "Indian Survivals in the Carolinas."

He gave a brief account of his summer's work with the eastern Cherokee on their reservation in the mountains of western North Carolina, and with some mixed-blood survivors, locally known as Croatan Indians, in the eastern part of the state. The Eastern Cherokee, numbering about 2,000, are descendants of those who fled to the mountains when the body of the tribe was removed to the Indian Territory in 1838. They still retain most of their aboriginal customs and beliefs, together with their language, although the larger tribal ceremonies are nearly obsolete.

The Croatans, so-called from an attempt to identify them with Raleigh's lost colony of 1585, are centered chiefly in Robeson County, to the number of about 8,000 according to the last census, with bands in adjoining counties and in South Carolina. They appear to be descendants of the original native tribes of the same region, largely mixed

with alien blood, the Indian blood still predominative, although they have completely lost all knowledge of Indian customs, language or tribal names. They are intelligent and prosperous people, farmers and small tradesmen, fully up to the level of their white neighbors. They have official recognition from the state as Indians, with a separate school appropriation and support of a small paper called the *Indian Observer* devoted to their interests.

Mr. Hodge gave an exhibition and talk on the speech and civilization of the seventeenth and eighteenth centuries in New Mexico. Dr. P. Radin spoke on "Some Archeological Problems of the Winnebagoes." Dr. Hrdlička suggested that the physical anthropology of the skulls found in the Wisconsin mounds should be taken into consideration by the speaker.

THE 456th regular meeting of the society was held in the new National Museum, November 14. The speaker of the evening was Mr. W J McGee, on "Conditions Limiting the Growth of Population in United States." His talk was an elaboration of his paper in *SCIENCE* (October 6, 1911, pp. 428-435).

THE 457th regular meeting of the society was held in the new National Museum, January 16. The speaker was Dr. J. W. Fewkes, who lectured on the "Western Neighbors of the Prehistoric Pueblos," illustrating his remarks with lantern slides. The early Spanish discoverers, he said, designated the habitations of the sedentary Indians of the southwest by several names, as pueblos, casas grandes, rancherías and trincheras, the word pueblo being especially assigned to a compact several-storied community house of terraced form represented most abundantly along the Rio Grande River. The large houses on the Gila they called casas grandes, and they gave the name rancherías to fragile-walled dwellings made of brush and clay supported by logs. Defensive walls were sometimes called trincheras. Each of these names indicates distinct architectural types, although they were not used with accuracy. In late years it happens that all ruined buildings of the southwest, especially those independent of cliffs, are called pueblo ruins, the culture of the people that once inhabited them being designated the pueblo culture. It is well to preserve the term pueblo for the crowded-terraced many-storied buildings to which it was originally applied, and when this is done the distribution of the pueblo

type in our southwest is considerably restricted. The stone ruins ascribed to the ancient sedentary inhabitants of Arizona from the Upper Verde River west to the Colorado are not true pueblos. In this region there predominated massive stone forts of magnitude and fragile-walled houses with stone foundations, a duality everywhere evident. The indications are that both kinds of buildings were constructed and used simultaneously by the same people. The forts, situated on almost inaccessible hill tops, were asylums for safety, and more perishable buildings on the river terraces were habitations near aboriginal farms. The great number of these forts on the western border of the pueblo region implies a great necessity for defense along the whole western border of Arizona and Sonora in Mexico.

Dr. Fewkes gave a brief account of the different forts and terrace dwellings on the Upper Gila and its tributaries, Sycamore and Granite creeks, the Chino and Williamson valleys and Walnut Creek to the mouth of the Santa Maria and other tributaries of the Colorado, all examples cited substantially agreeing in the duality of architectural type and the absence of true pueblo structure.

The simple construction of the forts and the rude character of the masonry made of undressed stone, without mortar, was referred to. Views of the remains of dwellings or rancherias on the river terraces were shown and commented upon. Terrace sites indicated by rectangular and circular rows of stones and low mounds occur all along the Chino and Walnut valleys to Aztec Pass. These show no evidences of kivas or sacred rooms, or many-storied dwellings. The pottery found near them is rude, sometimes decorated; the pictography is characteristic; the people made extensive irrigation ditches.

The most important forts mentioned were those on the Upper Verde, near del Chino, and on the limestone ridge west of Jerome Junction. Two important forts (one situated near the mouth of Walnut Creek and the other at Aztec Pass, the latter being the "pueblo" first described by Wheeler) were referred to by the speaker. Maps of the Walnut Creek region are defective, the most prominent elevation, Mount Hope, being wrongly located on some of the latest issued by the land office. Big Burro and other streams west of Aztec Pass have forts overlooking enormous canyons of great scenic interest.

The geographical distribution of the forts and trincheras in western Arizona corresponds in a general way with the northern extension of the

Yuma stock, according to Major Powell's linguistic map. The country west of the Verde Valley in which the ruins occur was peopled by Yavapai, Hualapai, Havasupai, and other Indians called by Cortez, Apaches. The Havasupai, who now live in the depths of the Cataract Canyon, and the Hualapai are said to have legends that their ancestors constructed some of the buildings considered. The Hopi Indians dwelling in the pueblo Oraibi claim that certain of their clans came from the west and that they are of Yuma stock. The question of the kinship of the ancient builders is of interest to the physical anthropologist as well as to the linguist and student of culture history. As the Indians of the Yuman stock formerly extended to the Pacific, the possible kinship of the western neighbors of the pueblos to tribes of Southern California is significant.

Dr. Aleš Hrdlička in discussion said that the results of the direct study of man himself in the region west of the pueblos agree in a large part with the conclusions arrived at by Dr. Fewkes, but in part they also differ. It is quite possible that the region about and west to southwest of the Aztec Pass was once occupied by either the Mohave or Yuma. The people against whom they had to defend themselves, however, were more probably the Apaches. The Walapai and Suppai, who to-day speak the Mohave language, are physically Apache, and the same is true of the Yavapai. As the Apache type is a very distinct one, this conclusion is quite definite. Both tribes contain, of course, some Mohave and probably also Pueblo admixture.

Dr. Hrdlička showed a series of views of special Suppai and Walapai huts which are related to those of the Apache but which are totally distinct from those of the Mohave and Yuma, and numerous types of men and women from the several tribes, showing great resemblance between the Walapai and Suppai and the Apache, while the Mohave resemble much more closely the pueblos.

Mr. George Stetson then spoke on the Code of Hammurabi. His remarks showed how humanitarian the code was, and what an advance it was on Roman law in several respects, though antedating the latter by centuries. The speaker also demonstrated how the laws of various states of the union and certain foreign nations might well be advantageously amended on the lines of the code under discussion.

TRUMAN MICHELSON,
Secretary

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The Evolution of the Vertebrates and Their Kin

By **WILLIAM PATTEN, Ph.D.**

Professor of Zoology and Head of the Department of Biology in Dartmouth College, Hanover, N. H.

EXTRACT FROM PREFACE

It is not fifty years since the doctrine of evolution has been generally recognized, and during the latter half of that period surprisingly little persistent, or concerted work has been done on the larger problems of phylogeny, and there is but little to justify the too common attitude that the possibilities of morphology are exhausted. Much disconnected fragmentary work has been done, but how little is known about the evolution of any one organ or system of organs; how very few animals, if indeed there are any, whose structure, development, and paleontological record are known with even approximate fullness or accuracy. What large class of animals is not separated from its next of kin by a gap too wide to be bridged by any known forms? Are these gaps due merely to a hiatus in the available records, or in our knowledge of them, or are they realities, representing periods of unusually rapid transformation due to sudden changes in the methods, or conditions of growth? If the gaps between the vertebrates and ostracoderms, and the ostracoderms and arachnids appear to be wide ones, are they really any wider than those between the fishes and amphibia, the reptiles and mammals, or the coelenterates and arthropods? Are not the evidences of genetic relationship of the same nature and value in one case as in the other? Is not the paleontological record more precise and complete than we have supposed? Will not embryology be less enigmatic under a new interpretation? If the arachnids are indeed the next of kin to the ostracoderms, and through them to the vertebrates, is that after all so incredible? With this gigantic column in position, will not the remaining branches readily fall into their natural positions and the entire genealogical tree of the animal kingdom take on the convincing symmetry and coherency of reality, of a living, growing organism that contains the story of its own creation?

* * * * *

These are some of the problems bound up in the evolution of the vertebrates. Clearly it is not merely a question of constructing a convenient and more or less satisfactory genealogy of the animal kingdom. The whole philosophy of creative evolution is involved in the answer.

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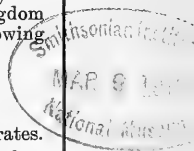
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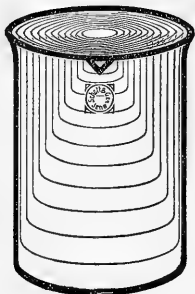
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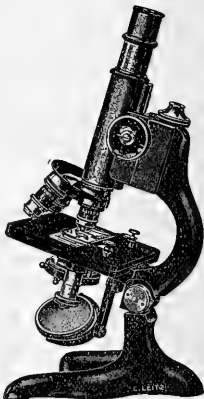
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SOME BIOCHEMICAL PROBLEMS IN BACTERIOLOGY¹

THE Society of American Bacteriologists stands, primarily, for pure as distinguished from applied bacteriology. In these days when the applications of the science are becoming so immensely important, and therefore so enticing to the investigator, there is danger that our thoughts turn not often enough to the broader aspect of the science, upon which, as a foundation, all of its applications must ultimately rest. We as a society must make it our special duty to see that these foundations are laid broad and firm, upon the very bed rock of truth itself.

We have as a society been interested for some time in the preparation of standard and uniform methods of describing bacterial species. This is of fundamental importance, leading as it does to uniformity of method and completeness and comparability of results. When we couple with this the use of the standard methods of the laboratory section of the American Public Health Association we have gone a long way toward the standardization of our work, and have begun the foundation upon which can be built the science of pure bacteriology.

But we must ever beware that we become not slaves to standardization and uniformity. It is well enough to proceed by standard methods, but we must not be tied by them. We must ever be ready to abandon the old and adopt the new, when the new marks the way of progress.

¹ President's address before the Society of American Bacteriologists at the Washington meeting, December 28, 1911.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

At this time I wish to bring to your attention some of the lines along which we are making little progress, I believe, because of the false security which we are taking in our standard methods.

First, suppose we consider our ordinary culture media. We have drawn up ridiculously exact procedures for mixing and boiling and filtering and titrating our broth, agar and gelatin, and when we are through we believe we have a standard, uniform product. But indeed it is not so. Not only are the results obtained in different laboratories unlike, but two lots of the same medium made at different times in the same laboratory are extremely unlike, when measured by the delicate physiological properties of organisms which respond to the slightest of chemical differences. Far better, it is true, are the results secured at the present time by the use of standard methods, than before their introduction, and I do not for a moment want to decry our standard methods, but I simply want to warn against the false security which their use may give. For however careful we may be in the process, the final result can never be uniform as long as the ingredients used are themselves variable. No medium can be standardized, that is, can be exactly duplicated at another time or place, if it contains such variable materials as beef extract, either freshly made or commercial, peptone, gelatin, agar, blood serum, bile, etc. I am inclined to think that in order to get uniform results, particularly in our study of the delicate physiological properties upon which we depend so largely for the differentiation of bacterial species, the time has come for us to abandon altogether the use of all complex and variable animal and vegetable products, and in their places to substitute materials of definite, known, chemical composition. From my work of

the past few years I am led to believe that for every organism it is possible to prepare a synthetic medium containing chemically pure salts, upon which these organisms will grow and grow well. Such a medium as this we are able to duplicate exactly anywhere and at any time.

In the past we have been inclined to think that the physiological properties of many organisms were too variable to be of much use in species determination. I am coming more and more to think that it is not so much the properties of the bacteria which are variable as the environment in which we have attempted to study them. We talk about rejuvenation of organisms to restore them to normal conditions. Our attempts at rejuvenation are attempts to make normal organisms adapt themselves in short order to an abnormal environment. Could we but supply the proper environment we should find the organisms responding in an entirely normal and uniform manner. It is the environment, our culture media, that need rejuvenating and not the organisms. This rejuvenation will come about, I believe, through the adoption of synthetic media of absolutely known chemical composition. Then the physiological properties of organisms will come into their proper place in species differentiation, for then we can substitute the exact qualitative and quantitative tests of the chemist for the inexact determination of the present-day bacteriologist.

There is scarcely a physiological property of the bacteria that is to-day accurately measurable. Variations in the media are so great that measurements at present amount to nothing. Chemistry advanced to its present position as a science only when it became quantitative. Lord Kelvin said: that "When you can measure what you are speaking about, and

express it in numbers, you know something about it; but when you can not measure it, when you can not express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science." Bacteriology must then become quantitative before the real foundations of the science are laid, before it can take its proper place among the sciences. And it can not become quantitative until we can measure its reactions in media of known chemical composition, by methods as exact and definite as any known to the chemist. We are always dealing, it is true, with living protoplasm, but if we place it under definitely determined environment, recent experiments lead us to believe that living substance always responds in a perfectly definite way both qualitatively and quantitatively.

The very complexity of the society's card for the description of bacterial species is to me its own condemnation. It is our admission of ignorance. Are not the real diagnostic characters of a species lost in a maze of unessential characters? Aside from the morphological data, which I believe is all-essential, the cultural and biochemical data could, I am sure, be simplified to a very considerable extent as far as species differentiation is concerned. The forms of cultures and colonies are but functions of the morphology and methods of subdivision of the organisms themselves, as has been so well shown by the recent work of Graham-Smith.² We might then eliminate from the card many of the complex descriptions of cultures and colonies on agar and gelatin, retaining perhaps the agar streak and the gelatin stab, and sub-

stitute therefore information in regard to their determining factors. And then among the biochemical data if we could eliminate all but a few deep-seated physiological characters which are accurately measurable, and which can be easily determined by means of accurate chemical tests on synthetic media of known composition, we would have a simple, accurate, all-sufficient description of a bacterial species.

One of the weakest parts of bacteriology to-day is its taxonomy. Our methods of classification of bacteria are practically the same to-day that they were in the earliest days of the science. Migula, it is true, systematized the scheme of classification to a certain extent, Chester contributed to its more accurate terminology, and the Winslows gave it a new impetus by the introduction of the methods of biometry. But when we think of the thousands of described species among which but two or three genera are recognized, it must be apparent at once that some of our generic names are seriously overworked. In other biological sciences the classification into species, genera, families, orders, classes, etc., is not only of great convenience, but it also expresses for us something of the relationship of the different groups, something of their probable ancestry and line of evolution. I see no reason why the bacteria should not be classified in the same way. The bacteria are not exceptions to the general biological laws. Variation, selection, heredity, are the factors of evolution here as elsewhere. It is true among the unicellular forms we are free from many of the complications which enter into our discussions of the origin of species among multicellular animals and plants. Sexual reproduction is absent, there is no differentiation into germplasm and somatoplasm to prevent the acquisi-

² Graham-Smith, G. S., "The Division and Post-fission Movements of Bacilli when Grown on Solid Media," *Parasitology*, 3, 1910, 17.

tion of new characters, the environment presses very closely upon these unicellular forms and they respond more directly to it. Generation follows generation with startling rapidity, elimination of the unfit proceeds rapidly, the struggle for existence is more severe because of the enormous numbers concerned. In the bacteria we ought almost to be able to see the actual process of evolution since we can place under observation untold numbers of generations as compared with the comparatively few generations of multicellular forms which we are able to observe. Eons of multicellular time are literally compressed into a few unicellular days.

Because of this lack of the regulating influence of reproduction and the greater influence of the environment and the rapidity of reproduction, we might expect to find among unicellular organisms a series of intergrading forms without divisions into groups that resemble the species of higher forms. But this is not so. Among the protozoa differentiation has followed definite lines, and classes, orders, families, genera and species are well marked. The species of protozoa are, for the most part, based on morphological differences, it is true, but among the bacteria a morphological basis of classification fails us. The only morphological differences are the three main divisions as to shape, the round, the rod and the spiral, with slight modifications as to size, arrangement of flagella, formation of spores, chemical composition, etc. But in spite of this lack of morphological basis for classification we find as distinct groups as among the protozoa. As the Winslows say:³

Typhoid germs descend from typhoid germs, tubercle bacilli from tubercle bacilli. The same

yellow coccus falls on gelatin plates exposed to the air all over world. The same spore-forming aerobes occur in every soil, the same colon bacilli crowd the intestines of animals and man in every clime. These fundamental types can not be transformed into each other.

And yet to a considerable extent these fundamental types are based not on morphology, but upon physiological differences.

It is among the bacteria that for the first time among living forms we find physiological differences made a basis for classification. Are physiological properties valid criteria for the separation of species? We are accustomed to think of morphological characters as fairly stable, rather difficult to modify, but of physiological characters as easily modified and directly dependent upon the environment. But have we any reason to assume that physiological characters are not deep seated also, are not stable, fully as much as morphological characters? Are we not in reality dealing with characters of the same sort as morphological characters except that we can not see their ultimate basis in structure? I am not sure but what physiological characters are even of greater importance than those of form and external appearance, especially in such simple and undifferentiated forms as the bacteria, since they testify to deep modifications in the chemistry and vital properties of the protoplasm itself. It is upon such chemical properties as these that these simple organisms depend for their very existence, and not upon a modification of external appearance.

But before we can proceed far in the use of physiological differences for species determination we must be able accurately to determine these delicate characters. Hitherto this has been impossible because of the variable and uncertain culture

³ Winslow and Winslow, "Systematic Relationships of the Coccaceae," p. 1, John Wiley and Sons, 1908.

media in which we have attempted to study them. With the adoption of media of definite chemical composition for making our determinations and measurements, the physiological characters of the bacteria will assume the importance of the morphological characters of higher organisms. Then and then only shall we be able to arrive at a natural classification of bacterial species which shall express for us their true relationship.

With the adoption of such accurate chemical tests of the physiological characters of the bacteria much of the present apparent variation will pass away and we shall find the physiological characters of the different groups as stable as any of their morphological characters. And what little variation remains—and we shall always find some variation as long as we deal with living organisms—we can handle easily by the method of biometry. For, as you know, the methods of statistical variation can apply only in characters which are measurable.

This matter of better methods of species identification and a new taxonomy will be one of the first outcomes of the adoption of simple chemical culture media.

Another important result will be the increased ease with which certain biochemical problems in bacteriology can be attacked. Think for a moment of our endeavors to find a suitable method of isolating the colon bacillus. Litmus-lactose-agar, endo, esculin, neutral red, malachite green, phenol, bile and bile salts and their various combinations are but expressions of our total ignorance of the chemistry involved. The problem should be attacked in an entirely different way. First, we should determine the simplest synthetic medium upon which the colon bacillus will grow rapidly and well. Then by adding to it the chemical body which is the in-

hibiting agent in the phenol or in the bile we ought to have the ideal medium for colon isolation. A beginning along this line has been made by Dolt⁴ in his ammonium lactate, glycerin and malic acid media. But further work must be done until we have a simple synthetic substitute for the complex, variable and inconvenient media upon which we depend so much at present.

And then take the differentiation of the colon and typhoid groups by cultural characters. There must be certain chemical differences inherent in these organisms which could be easily determined by the use of synthetic media adapted to each organism.

Another desideratum is a simple synthetic medium to be used as a substitute for blood serum when used for the diagnosis of diphtheria. We have to depend at present upon the uncertain and unsatisfactory supply of blood from the abattoirs. How much better would it be to find a chemical substitute which would be just as certain for diagnosis and much easier to prepare? I believe that such a substitute will soon be forthcoming.

We have been gradually accumulating a knowledge of a considerable number of important chemical products which are produced by the activities of bacteria either by synthesis or decomposition. Many of these substances are of great importance. Many are produced only as far as we know at the present time by bacteria. How little at present we know of the chemistry of these products! How much can be learned by a study of the formation of these substances in culture media of known composition! The chem-

⁴Dolt, M. L., "Simple Synthetic Media for the Growth of *B. coli* and for its Isolation from Water," *Journal of Infectious Diseases*, V., 1908, 616.

istry of ptomaine and toxin formation, of pigment formation, of enzyme production, may be worked out in this way. The chemist laughs at our present methods of testing the production of gas, the reduction of nitrates, the production of indol, the fixation of nitrogen. And yet when these processes are tested in synthetic media how simple are the chemical tests involved and how accurate may be the results!

Slowly and laboriously the physiological chemist is now trying to work out the chemistry of protoplasm, of the proteins, such as the albumens, the peptones and proteoses. His principal line of attack is by a study of their decomposition products. The brilliant work of Fischer opened up an entirely new field of research when he undertook the study of the synthetic production of the polypeptides from amino acids by an amide link. Still more light might be thrown upon this important problem by the study of the growth of bacteria in simple chemical solutions. For in the synthetic culture medium we would be able to study step by step the synthesis of protein under conditions accurately controlled and completely known. For when bacteria are growing on simple chemical media and are building up untold millions of bacterial bodies from the simple salts present, we can almost see protoplasm in the making.

And finally, aside from the important chemical information which may in this way be obtained, I believe that some most interesting biological information lies along this path. Who would dare to deny that some day it might be possible by some such method as this to discover the secret of the very origin of life itself!

These then are some of the lines of work which appear to me to mark progress in the science of pure bacteriology. Brill-

iant as may be the results of the study of the applications of bacteriology, fully as interesting, and hardly less important, will be the results that come from the application of exact chemical methods to our at present inexact and rather uncertain bacteriological procedures.

F. P. GORHAM

BROWN UNIVERSITY

*THE TEACHING OF MICROBIOLOGY IN
COLLEGES OF UNITED STATES
AND CANADA¹*

IN his admirable presidential address delivered before the Society of American Bacteriologists at the Ithaca meeting in December, 1910,² Professor V. A. Moore made a strong argument for bacteriology as a science for general culture as well as for professional value, and a vigorous appeal for better teaching and more carefully developed courses. As a result of this exposition of the subject a committee of this society was appointed to make a systematic inquiry into the teaching of microbiology, including bacteriology, protozoology and the study of the lower fungi, in the educational institutions of the United States and Canada.

The purpose of the inquiry is primarily to learn to what extent bacteriological instruction is given in these institutions, and secondarily to note the character of the teaching in these subjects and the scope of the work. It is possible that as a result of these data submitted the committee may be able to formulate a generally broad and satisfactory plan of instruction in this subject, although this is not the immediate purpose of the committee and it is possible that an attempt to do so would react harmfully in certain instances.

While it is hoped the inquiry will eventually embrace institutions of all ranks, the first report of progress presented at the Washington meeting dealt only with the colleges and

¹ An abstract from the first report of progress by the Committee on Education of the Society of American Bacteriologists.

² SCIENCE, N. S., Vol. XXXIII, No. 843.

technical schools. These may be classed as follows: (1) The colleges of arts and sciences leading in general to the A.B. or S.B. degree; (2) the colleges of agriculture; (3) the colleges of medicine; (4) the technical schools or schools of applied science.

At the outset it should be said that the report on the teaching in these institutions is far from complete, that many schools have not supplied information, and that the following statements form merely the beginning of what, it is hoped, will be a comprehensive and useful study.

The chairman of the committee early in the year prepared a set of questions which were submitted to the other members of the committee for suggestions and desirable changes. These were incorporated in the final list. These questions have been submitted to about 550 institutions of the rank as stated above in the United States and Canada. The collegiate institutions of Canada were not found in any list of the colleges available, but a list was obtained by direct application to the Canadian commissioner of education, to whom cordial thanks are extended. The questions were as follows:

1. What courses in bacteriology, if any, are given in your institution?
2. How many hours of lecture, recitation and laboratory work are devoted to each?
 - Lecture
 - Recitation
 - Laboratory
3. Is the subject a required one, or elective?
4. At what year in the college course is it given?
5. To what group (department) or groups of students is it given?
6. What preliminary training in biological sciences is required?
7. What preliminary training in physics, chemistry, mathematics and languages is required?
8. Is the subject presented as
 - (a) Part of a course in general biology or botany?
 - (b) As a general science course for its educational value?
 - (c) As a special or professional course in applied science?
 - (d) As a part of any other course? If so, what course and how extensively?

9. If more than one course is given, will you state the scope and character of each, and the approximate number of students in each?
10. If the courses are given from the applied science standpoint, are they given in their relation to
 - (a) Medicine?
 - (b) Public health?
 - (c) Dairying?
 - (d) Soil and agriculture?
 - (e) Industrial processes?
11. What is the character of the laboratory work actually performed by the students, *i. e.*, how elaborate experimentation do they actually do?
12. Are the students directed in what might be called research work in bacteriology, *i. e.*, advanced work and investigation, aside from ordinary routine class work?
13. What books do you use as text-books for the course?
 - As collateral reading?
14. What courses in protozoology are given?
15. What text and reference books used?
16. What courses devoted to other branches?

Replies have been received from 121 of these and it is on the basis of the replies received up to the present time that the following tabulations and statements are made. A second list of questions has been submitted to those institutions of the original list and supplementary institutions not on the original list from which no replies had been received up to December 21. The failure to reply undoubtedly means in certain instances that no courses are given or that there is no professor dealing with the subject in hand, and consequently letters have failed to be properly received, or there may have been oversights on the part of the professor in charge. Because of the possibility of the second alternative it has seemed desirable to send out the second set of questions.

The replies which have already been received in response to the circular have been of much interest, and careful study may be grouped into a number of tolerably definite classes. In general the replies indicate fairly clearly the scope of microbiological instruction, and in several instances there have been

submitted course schemes showing the exact range of subject matter presented.

On the basis of the study of these replies the chairman has grouped the institutions into several classes which I have characterized as follows:

Group I.—Those institutions in which some phase of the subject of bacteriology is presented very briefly, and in general avowedly from the standpoint of general education, or in connection with courses in general biology, botany or hygiene given from the culture rather than the professional standpoint. Some actual laboratory work is done, however.

In addition there is sometimes an intention to introduce the student to some phase of applied bacteriology in a very brief way. These brief courses vary much in character and extent, and this group is, therefore, the most difficult to classify. A few have made pretentious claims which obviously can not be lived up to in the courses given.

In many of these courses the plan of attack seems to be well thought out, and the relations of lecture and laboratory work is well calculated to give the student a fair general introduction to the whole subject. However, it is only an introduction, and the student product can not be regarded as a trained bacteriologist. On the other hand, some of the courses seem to be badly balanced, to give an undue weight to lectures and too little to laboratory work, and to emphasize some particular and rather narrow phase of the subject.

The institutions which I have included in this group are 39 in number and include for the most part the smaller colleges, or those having no highly specialized courses in applied sciences leading to a professional degree. These courses are apparently sometimes taught by instructors who have had no special or thorough training in bacteriological methods, but who have gained some knowledge of the bacteria, and who have introduced the work in the curriculum because of their personal interest in the subject or their ability to adopt such knowledge to supplement courses already given. In none of these institutions is there any attempt to carry on worthy investi-

gations or research, although in a few of the replies it has been stated that "investigations" are conducted. Examination of the type of research, however, shows it to be trivial and to consist generally in the microscopical examination or plating out of bacteria from a water supply, milk supply or some such simple source. The consideration of this group of institutions can not fail to impress the members of the society with some of the statements made by the president in his address last year, in which he put in a forceful plea for more scientific methods in teaching and more training on the part of those giving instruction in this important subject in many institutions.

Group II.—This group includes institutions having in general but one course or at most two separate courses, but in which work is conducted on broader lines, with more abundant laboratory work and generally in which the teacher is himself a trained worker in some field of bacteriological study and in close sympathy with the subject.

The courses here grouped may in some instances be described as presented primarily for the educational value of the subject as seen in a broad way, and are given from the standpoint of general culture and in the same spirit as that exhibited in the teaching of courses of general chemistry, general botany or general zoology.

Frequently after a fairly broad and comprehensive introduction the work is later restricted to some special phase of bacteriology, as soil, dairy, or sanitary work, so that the subject is actually given with the applied science end in view.

In this group there are undoubtedly some courses which are poor in the sense that they fail to give to the student a broad knowledge of the fundamental principles underlying bacterial behavior and activity. In other words, the biology of the bacteria as a group of living things is frequently subordinated to the examination of water for colon bacilli or the microscopical study of a few restricted types, such as the more common of the pathogens. On the other hand, many of the replies from

institutions which should be placed in this group indicate that bacteriological instruction is on a good foundation, and may be built up with comparative ease when opportunity offers.

In these institutions investigation work of a legitimate character is frequently conducted, and the best of the institutions of this class are contributing valuable work to the sum total of our bacteriological knowledge year by year, through their researches.

I have grouped 22 institutions in this class, in half of which, probably, work of high character is being carried out, while in the others the results do not appear to be so satisfactory.

Group III.—In Group III. I have brought together 28 institutions. In 25 of these, as appears from the catalogues or from subject matter presented in the reports, there is what may be called a well-rounded department of bacteriology or microbiology, with a central fundamental course in general bacteriology. Following this and dependent upon it may be found well organized courses in several of the applied branches, such as soil bacteriology, dairy bacteriology, sanitary bacteriology, fermentation work and medical or public health work. Twenty-five of the twenty-eight institutions here grouped present the breadth of work which I have just described. In three of them the work is organized with a somewhat less broad scope, but it appears to be evident that the work in these institutions is excellent as far as it goes.

Group IV.—In ten institutions, which are almost without exception medical departments or pre-medical courses, the work in bacteriology is arranged with one point in view, namely, to introduce to the student the more common of those types of microorganisms which are the causes of disease. It seems to me that the chief criticism to be made of these courses is that the student loses sight entirely of the important general relations of the bacteria to human welfare and is likely to regard the group simply from the standpoint of disease-production and never from the standpoint of industrial or economic value, or from the standpoint of general culture. In

all the institutions of this class, the work is carried out in the graduate department or in the school not connected with the university, and in the former case no serious attempt is made to interest undergraduate men in the subject at all.

Group V.—I have made a separate group for those institutions, schools of engineering, in which a smattering of bacteriology is given to civil or sanitary engineers, in order that they may more properly appreciate sanitary problems. This group is very small, replies having been received from but few institutions. In these the narrowest kind of instruction is given, and the matter is presented in such a way as to leave the impression with the student that deciding upon the sanitary condition of the water supply is a perfectly simple matter requiring no special training. For example, one of the institutions which reports having a class in water bacteriology, states that the number of lectures given in the subject is but four, the laboratory work of the three brief periods and consisting in the examination of but one sample of water and one sample of sewage for the total count and presumptive test for colon bacilli. In the opinion of the writer such courses do positive harm, because they give to the student a false sense of knowledge and ability to decide problems which may be of the utmost importance for the welfare of thousands of people.

The remaining replies may be all grouped in a class together. This includes eighteen institutions. In seventeen of these no real courses in bacteriology are given, although the informants have stated that brief consideration of the subject is taken up in connection with botany, physiology or hygiene. No laboratory work is done, however, and it is evident that these institutions do not require any special consideration. In one of the institutions here grouped, a brief course is given in the examination of bacteria, yeasts and molds, from the standpoint of household economics. The work, however, is very elementary in character.

While it is somewhat disappointing to receive replies from less than one fourth of the

institutions to which the sets of questions were sent, this possibly represents a fairly high proportion of institutions in which instruction in this subject is given. While I am certain that well-defined bacteriological courses are presented in several institutions from which no replies have been received, a survey of the institutions with which I am familiar would lead me to believe that the replies had come probably from a majority of the schools giving bacteriological instruction. From the standpoint of geographical distribution, it seems to be evident that the middle west has done more in the promotion of microbiological education by the installation of courses than has the east or the south. Practically all the central and western state universities and agricultural colleges seem to have well-defined courses, and since these schools occupy very prominent positions in the field of education in the west, it appears to be evident that the student of the central and western part of the country has a greater opportunity to take work in this subject than has the eastern student, who is more likely to attend the privately endowed institutions. New England, with approximately thirty-five colleges and technical schools has, outside of the purely agricultural colleges, but five institutions in which comprehensive bacteriological instruction is given to the candidates for the Bachelor's degree in arts or science. No definite courses are offered in the collegiate department at Harvard, Yale, Dartmouth, Williams, Amherst, Bowdoin, Columbia, Princeton, Pennsylvania or Colgate, and this list could, with a little consideration, be very greatly extended.

It does not seem to the writer that this is the time to suggest methods of instruction, or the exact ground which should be covered in microbiological subjects. It is, however, worth emphasizing that the proper interpretation of bacteriological problems can not be had until the instruction in bacteriology is placed upon a very broad biological and physiological basis, and until there are correlated with such courses training in physics, chemistry and mathematics. These correlated subjects

should be of sufficiently advanced character that the student may consider the organisms in their physical, chemical and biometric relations, for it must be admitted that modern bacteriology includes far more than the microscopical examination and cultivation of a few pathogenic types.

SAMUEL C. PRESCOTT

*A BOTANICAL-ZOOLOGICAL LABORATORY
IN PORTO RICO*

THE University of Porto Rico announces that it plans to offer to students facilities for research in botany and zoology in the American tropics.

Special space will be set aside in the agricultural building now in process of erection and the well-equipped physical, chemical, botanical, zoological, bacteriological and plant pathology laboratories may be drawn upon for supplies and apparatus. The research laboratories will be equipped only with the usual essentials, but endeavor will be made to meet special needs, in the way of equipment, which the problems of each student demand.

It is probable that a seaside laboratory, within a few yards of the ocean, will also be provided with needed equipment, including a motor launch for marine collecting, and that a third laboratory will be located on some suitable elevated region. These facilities will be extended to all who are competent to use them and are properly accredited by reputable institutions.

Free tables will be provided for a limited number of advanced students under conditions which will be explained upon communication with the director.

Students who desire to use the laboratories are requested to communicate, as early as possible, to the director, their needs and dates at which accommodation is desired, since there is often delay in procuring supplies.

For the information of prospective students, the following data are given:

Porto Rico lies between 17° 54' and 18° 30' north latitude. Geologically it is of much interest, though but little studied as yet. It is extremely rugged and picturesque with its

many volcanic peaks, some rising over 3,700 ft. Caves abound. The climate is delightful and healthful; the nights cool. The mean annual temperature is 76°, the average during the coolest winter month 73°, during the warmest month 79°. The early morning temperature averages 70° in summer, 63° in winter. The average daily maximum is 88° in summer, 83° in winter. The highest temperature recorded on the island last year was 99°. The highest at Mayaguez was 96°. Vegetation is beautiful, distinctly tropical and luxuriant.

The pelagic flora and fauna of the Mona passage are especially interesting. Trawls, dredges, aquaria, etc., will be provided. Fine opportunity is offered for the study of animal and plant anatomy, embryology, physiology, taxonomy, morphology, experimental morphology, ecology, climatic relations and breeding; tropical fauna and flora, marine and land, and problems on geographic distribution and bird migration.

Correspondence of all interested is invited. All who intend to come for summer study, or for other portions of the year, should write several months in advance.

F. L. STEVENS,
Director

SCIENTIFIC NOTES AND NEWS

THE lord provost of Glasgow proposes to convene a conference to promote an international memorial to Lord Lister in Glasgow.

FOR the meeting of the British Association for the Advancement of Science, which is to be held this year at Dundee, beginning on September 4, under the presidency of Professor E. A. Schäfer, F.R.S., the following presidents have been appointed to the various sections: Mathematical and Physical Science, Professor H. L. Callendar, F.R.S.; Chemistry, Professor A. Senior; Geology, Dr. B. N. Peach, F.R.S.; Zoology, Dr. P. Chalmers Mitchell, F.R.S.; Geography, Sir Charles M. Watson, K.C.M.G., C.B., R.E.; Economic Science and Statistics, Sir Henry H. Cunyng-hame, K.C.B.; Engineering, Professor A. Barr; Anthropology, Professor G. Elliot

Smith, F.R.S.; Physiology, Mr. Leonard Hill, F.R.S.; Botany, Professor F. Keeble; Educational Science, Professor J. Adams; Agriculture, Mr. T. H. Middleton.

PROFESSOR CHARLES SEDGWICK MINOT has been selected by the German government as Harvard exchange professor at the University of Berlin for 1912-13. Dr. Rudolf Eucken, professor of philosophy at Jena, has been appointed exchange professor at Harvard University.

DR. WILLIAM T. BRIGHAM, director of the Bishop Museum, Honolulu, has been made a corresponding member of the Imperial Academy of Science, St. Petersburg, and of the Senckenbergische Naturforschende Gesellschaft at Frankfurt.

THE following have been elected correspondents of the Academy of Natural Sciences of Philadelphia: Viktor Goldschmidt, Carlotta J. Maury, John Casper Branner and Charles Haskins Townsend.

PROFESSOR W. ODLING, F.R.S., of Oxford University, has resigned the Waynflete professorship of chemistry, which he has held for forty years.

PROFESSOR A. H. PURDUE, who for nearly sixteen years has held the chair of geology in the University of Arkansas, and since 1907 ex-officio state geologist of Arkansas, has been elected state geologist of Tennessee to succeed Dr. Geo. H. Ashley, resigned.

D. W. OHERN, professor of geology at the University of Oklahoma, has been appointed director of the Oklahoma Geological Survey to succeed Chas. N. Gould, who has resigned to enter private work.

MR. MYRON L. FULLER, a geologist on the U. S. Geological Survey, and Mr. Frederick G. Clapp, formerly of the survey, have organized an association known as the Bureau of Associated Geological Engineers with offices in Boston and Pittsburgh.

MR. E. NEVILLE NEVILL, director of the Natal Government Observatory, Durban, is retiring from office, and will in future live in England.

PROFESSOR J. A. GILRUTH, professor of veterinary pathology in Melbourne University, has been appointed administrator of the northern territory by the commonwealth government.

THE Liverpool health committee has recommended the city council to lend the city engineer, Mr. J. A. Brodie, to the government of India for the purpose of assisting in laying out the new capital of India.

PRESIDENT TAFT appointed the following scientific men on the recent Assay Commission: Professor John Trowbridge, of Harvard, Professor G. W. Stewart, of the University of Iowa, Professor O. L. Shinn, of the University of Pennsylvania, Professor R. C. Benner, of the University of Pittsburgh, Dr. M. Benjamin, of the Smithsonian Institution, and Dr. L. A. Fischer, of the Bureau of Standards.

THE Entomological Society of America has appointed Professor John B. Smith, Rutgers College, Dr. L. O. Howard, chief, Bureau of Entomology; Dr. E. P. Felt, New York state entomologist; Dr. W. M. Wheeler, Harvard University, and Dr. W. E. Britton, Connecticut state entomologist, as delegates to the centennial of the Philadelphia Academy of Sciences, to be held on the 19th, 20th and 21st of March. Professor George Grant MacCurdy will be the delegate from the Paris School of Anthropology.

THE anniversary meeting of the Geological Society of London was held on February 16, when officers were appointed as follows: *President*, Dr. A. Strahan, F.R.S.; *vice-presidents*, Professor E. J. Garwood, Dr. J. E. Marr, F.R.S., Mr. R. D. Oldham, F.R.S., and Professor W. W. Watts, F.R.S.; *secretaries*, Dr. A. Smith Woodward, F.R.S., and Mr. H. H. Thomas; *foreign secretary*, Sir Archibald Geikie, K.C.B., president R.S.; *treasurer*, Mr. Bedford McNeill. The following awards of medals and funds were made: Wollaston medal, Mr. Lazarus Fletcher, F.R.S.; Murchison medal, Professor Louis Dollo; Lyell medal, Mr. Philip Lake; Wollaston fund, Mr. C. I. Gardiner; Murchison fund, Dr. A.

Morley Davies; Lyell fund, Dr. A. R. Dwerryhouse and Mr. R. H. Rastall.

DR. SVEN HEDIN is planning a new expedition to Asia.

AN expedition to Newfoundland will be conducted next summer by Professor R. S. Tarr, of Cornell University, to which a limited number of students will be admitted. The geology and physiography of the island will be studied in the field. The party will carry its own camping equipment.

PROFESSOR RAYMOND J. POOL, of the University of Nebraska, has been granted a leave of absence from May 15, in order that he may continue his studies of the vegetation of the Sand Hills of Nebraska. It is planned to extend the detailed work of last summer over a wide territory and into portions of the hills that have never been visited by botanists. Special attention will be paid to the bunchgrass association, to the preparation of vegetation maps and to the vegetation (exclusive of the algae) of the alkaline lakes which are scattered in great numbers throughout the region. A collection of herbarium specimens will also be made. Professor Pool will be assisted by Mr. Donald Folsom, who is at present the collector for the department of botany in the university.

DR. DAVID T. DAY, of the U. S. Geological Survey, has gone to Vienna, Austria, to attend the meeting of the International Commission of Petroleum Testing Methods.

PROFESSOR A. A. MICHELSON, of the University of Chicago, will give the annual address before the Michigan Academy of Science at Ann Arbor on March 27. His lecture will be on "Iridescent Colors of Birds and Insects."

PROFESSOR H. S. JENNINGS, of the Johns Hopkins University, gave the tenth Hervey lecture at the New York Academy of Medicine on March 2, his subject being "Old Age, Death and the Meaning of Conjugation in Lower Animals."

AT the meeting of the Chemical Society at George Washington University on February 15, Dr. Frank Wigglesworth Clark, chief chemist of the U. S. Geological Survey and

professor of mineralogical chemistry at the university, gave an address on the "Composition of the Earth's Crust."

DR. L. A. BAUER, director of the Department of Terrestrial Magnetism of the Carnegie Institution, gave an address on "The Recent Cruise of the Non-magnetic Ship *Carnegie*" at the College of the City of New York on March 1.

THE following lectures have recently been delivered at the University of Missouri under the auspices of the Scientific Association: Professor W. Johannsen, of the University of Copenhagen, February 21 and 22, on "Modern Problems of Heredity"; Professor Albert Bushnell Hart, of Harvard University, February 24, on "America in the Orient."

A LECTURE on sanitation and public health, under the auspices of the department of sanitary engineering of the University of Pittsburgh, was given in Thaw Hall, on March 5, by Professor C.-E. A. Winslow, of the College of the City of New York. This was the third in this series of lectures, the others having been given by Professor Wm. T. Sedgwick and Dr. M. J. Rosenau, respectively. Professor Winslow discussed "Air Supply and the Public Health."

PROFESSOR GEORGE GRANT MACCURDY gave a public lecture in the University Chapel, Columbus, on the evening of March 1 by invitation of the Omega Chapter of the Sigma Xi of the Ohio State University, his subject being "Pre-Columbia Art."

PROFESSOR J. HOWARD MATHEWS, of the department of chemistry of the University of Wisconsin, gave an illustrated lecture on February 7 before the Purdue Chapter of Sigma Xi, at Lafayette, Indiana, on "The Scientific Applications of Color Photography."

UNDER the auspices of the department of geology, Professor Ellsworth Huntington, of Yale University, delivered three illustrated lectures on the general subject of "The Desert" at the University of Michigan, on February 28 and 29 and on March 1. The subjects of his lectures were: "Chinese Turkestan as an Example of the Relation of Deserts

to Geological Processes," "Palestine as an Example of the Effect of Minute Differences of Geological Structure upon History" and "Historic Changes of Climate as an Example of the Application of Geological Methods to Historical Problems."

DR. C. L. BABCOCK, of Boston, lectured under the auspices of the department of archeology at Oberlin College on March 5 on the excavations at Cnossus in Crete. Dr. Babcock studied the excavating done by Mr. Arthur Evans, the result of which was the discovery of what is very probably the palace of King Minos, so complicated in detail that it may well have been called the labyrinth. These discoveries have moved back the beginnings of European history well toward 10,000 B.C. The lecture was illustrated with a large number of stereopticon slides prepared by Dr. Babcock himself supplemented by others loaned from the Boston Museum of Fine Arts.

It is proposed to erect a monument to Dr. J. Janssen, eminent for his work in astrophysics. The officers of the organizing committee are: *President*, H. Poincaré; *vice-presidents*, B. Baillaud and G. Bigourdan; *secretary*, P. Puiseux; *treasurer*, H. Dehérain, Bibliothécaire à l'Institut, Paris, to whom contributions should be sent.

MR. GEORGE MAW, known for his important contributions to botany and other natural sciences, died at Kenley, Surrey, on February 7, aged eighty years.

THE death is announced at Bergen of Dr. G. H. A. Hansen, eminent for the discovery of the bacillus of leprosy in 1871.

M. EUGÈNE CAVENTON, the distinguished chemist and member of the French Academy of Medicine since 1870, has died at the age of eighty-three years.

THE committee on scientific research of the American Medical Association has charge of a small fund which is to be used to promote research. The committee is desirous that this money should be used to meet actual needs and to promote investigative work not otherwise adequately provided for. Applications

for grants are invited. The applicant should state fully the purpose for which the grant is desired; the qualifications of the applicant and the general opportunities and conditions under which the work is to be done. The members of the committee are Ludvig Hektoen, Chicago (1743 W. Harrison St.), Graham Lusk, New York, and Eugene L. Opie, St. Louis, Mo.

MR. GEORGE HENRY VERRALL, former Conservative M.P. for East Cambridgeshire, a former president of the Royal Entomological Society, who died on September 16, left his collection of British Diptera and the cabinets in which it is contained to his nephew, James Edward Collin, conditioned upon his offering to the Natural History Museum, South Kensington, three pairs of each species of which he possessed a full series (six pairs constitute a full series), and at least one pair of each species of which he possessed more than one pair; and all his real and personal estate in the parish of Wicken, Cambs, to the National Trust for places of historic interest or natural beauty.

THE Biological Survey of the Agricultural Department has secured the cooperation of the National Zoological Park in experiments in breeding mink for the purpose of ascertaining the possibilities of rearing them in captivity for commercial purposes.

UNIVERSITY AND EDUCATIONAL NEWS

GIFTS of over half a million dollars to the University of California have just been consummated, through the deeding of property by trustees for the late Mrs. Jane K. Sather, of Oakland. Plans have been begun for the Sather Campanile, a lofty bell-tower, for which Mrs. Sather provided some \$200,000. Two professorships are endowed; the Jane K. Sather chairs in classical literature and history will each have an endowment of approximately \$120,000. Endowment is provided for three book funds.

OFFICIAL record has been made in the city of Philadelphia of the transfer of the new tuberculosis hospital built and endowed by Mr. Henry Phipps to the University of Penn-

sylvania. The cost of the new building is \$300,000, and the entire project will represent an outlay of about \$1,000,000.

THE Illinois State Supreme Court has rendered a decision which declares unconstitutional an act of the last legislature which voted an item of \$60,000 for the medical school of the university. As many of the other acts of the legislature were passed in the same manner, there is considerable confusion in the minds of people as to what the outcome may be. It is thought that a special session of the legislature may be called to straighten out affairs.

THE departments of horticulture and plant pathology of the University of Wisconsin have moved into their new building. It is a two-story and basement brick structure, 48 by 128 feet, and with attic space for laboratories. The cost of the building was \$60,000, exclusive of the four greenhouses, potting house and pathologium, situated in the rear of the building. In the basement of the new structure are spray laboratories, fruit rooms and bulb rooms, while the offices, lecture rooms and general laboratories of the horticulture department are on the first floor. The second floor is given over to the plant pathology department, under Professor L. R. Jones. Professor J. G. Moore is at the head of the horticulture department.

THE royal commission on university education in London has recommended a building for the university to be placed on a vacant site of more than 100,000 square feet immediately behind the extension of the British Museum. The site consists of four plots, two on each side of the new British Museum Avenue, on one of which it is proposed that a spacious hall should be built for the university, the other three plots being used for administration, library, small lecture theaters and rooms for graduates. The site is part of the Bedford estate, and it is stated that the Duke of Bedford is prepared to dispose of it for the purposes suggested.

DR. ARTHUR HOLMES, assistant professor of psychology at the University of Pennsylvania,

has accepted the post of dean of the faculties of Pennsylvania State College.

THE following appointments have been announced for the medical department of the University of Pennsylvania: Dr. Edward Lodholz is to be assistant professor of physiology; Dr. W. N. F. Addison, assistant professor of normal histology; Dr. George H. Fetterolf, assistant professor of anatomy; Dr. L. A. Ryan, assistant professor of chemistry and toxicology.

DR. E. T. WHITTAKER, F.R.S., royal astronomer of Ireland, has been appointed professor of mathematics in the University of Edinburgh, in succession to the late Professor Chrystal.

DISCUSSION AND CORRESPONDENCE

REPLY TO HOLMES'S CRITICISM OF "LIGHT AND THE BEHAVIOR OF ORGANISMS"

IN a review of the book entitled "Light and the Behavior of Organisms," which appeared in this Journal, June 23, 1911 (pp. 964-966), the author raised several points that call for elucidation. Before entering upon the discussion of these points, however, I wish to take this opportunity to state my regret in having overlooked the work of several investigators bearing on some of the subjects treated, especially that of R. S. Lillie on the reactions of *Arenicola* larvæ, to which Holmes calls attention.

After referring to the numerous attacks made in the book in question, on Loeb's theories of orientation, Holmes says (p. 964):

Mast's own investigations seem to afford about as good support as has been furnished for the theory which he so persistently attacks.

He then gives two cases in support of his contention:

1. No clearer case of orientation through the local response of the part directly stimulated could well be imagined than the one afforded by *Amæba*, and the author admits that the "method of orientation is in harmony with much in Verworn's theory and also with the essentials in Loeb's." But he adds that "it does not, however, support the idea connected with these theories, that a constant intensity produces a constant directive stimula-

tion." I am not sure that I understand the pertinency of the criticism, for there is nothing in the theories of either of these writers which implies that the actual stimulating effect of any directive agency is subject to no variation.

2. Referring to orientation of *Arenicola* larvæ he says (p. 965):

Orientation in this form is apparently as automatically regulated an activity as one might expect according to the well-known theory of Loeb.

The point at issue here clearly concerns the question as to whether the methods of orientation in *Amæba* and *Arenicola*, as described in my book, are in accord with Loeb's theories of orientation. To settle this question it is of course necessary first of all to understand these theories. I say theories, for, contrary to my critic's assumption, there are three instead of one, as pointed out in my book, pp. 23-35, especially in the summary (p. 54) where the following statement is found:

In 1888 Loeb held that orientation in animals is controlled by the direction in which the rays of light pass through the tissue. From 1889 to 1903 he advocated the idea that orientation is controlled by the direction in which the rays strike the surface, or the angle they make with the surface. His statements from 1906 to 1909 indicate that he thinks that orientation is regulated by the relative intensity of light on symmetrically located sensitive structures on opposite sides of the organism.

The idea that orientation is the result of continuous action of light is common to all of these theories and is undoubtedly their most important distinguishing characteristic. Loeb has repeatedly stated this in unmistakable terms. Witness, e. g., the following statement found in "Dynamics of Living Matter" (p. 135): Heliotropism is "a function of the constant intensity," and the same idea expressed more fully in the same publication on pp. 117-119, 130-131, 138-139. My critic has evidently failed to grasp this idea in spite of the fact that I have repeatedly stated it in different forms in quotations from the references just given and others, indeed even to such an extent that one of my reviewers objects to the repetition as superfluous.

In order to show that an organism orients in accord with Loeb's theories it is conse-

quently necessary to prove that the response is due to "constant intensity," i. e., that the orienting stimulus acts continuously and is not due to changes of intensity. This I have been unable to do in any case whatsoever in spite of persistent efforts, and as far as I am aware it has never been done. It was owing to this that I made the statement that the orienting reactions in *Amoeba* do not support the idea connected with the theories of Loeb and Verworn that "a constant intensity produces a constant directive stimulation" quoted by Holmes. His failure to "understand the pertinency of this criticism," as he says, indicates that he did not understand these theories.

The second case which Holmes cites in support of his contention that my investigations lend support to Loeb's theories shows even more clearly than the first that he did not understand these theories. After admitting that in case of the orientation in *Arenicola* larvæ "the question remains open whether the stimulus is produced by the direct action of light on the sensitive surface of the animal or by changes in intensity of the stimulus caused by the lateral movements of the body" he maintains that orientation in these animals is in accord with "the well-known theory of Loeb" because it is "*apparently automatically . . . regulated*" (italics mine). Thus admitting that it can not be proved that orientation is due to continuous stimulation, he would make automaticity the criterion of Loeb's theories, ignoring all other distinguishing characteristics found in them.

It is true that Loeb often uses the term automatic in discussing reactions which he calls tropisms, but what does it mean? Automatic means mechanically self-acting, that is, involuntary. In accord with this definition are there any reactions whatsoever in *Arenicola* or in any other organism below man which are not automatic? Investigations and speculations without end have been directed toward the solution of this very problem and yet there are few bold enough to say that it has been solved for even a single case. Of what possible value then can automaticity be

as a distinguishing characteristic of a group of reactions supposed to be specific, and what bearing can the statement that the orienting reactions of *Arenicola* larvæ are *apparently automatic* have on the mechanics of orientation (tropisms) of this or any other organisms?

It is precisely such loose and uncritical statements as Holmes has made regarding Loeb's theories with the suggestion of such impossible criteria as automaticity that have brought the discussion centering around the term "tropism" to the chaotic condition in which it is found at present. To show that a reaction is in accord with any one of Loeb's three theories it must of course be demonstrated that it is in harmony with all of its characteristics, not merely with one of them, as my critic seems to imply. It must be proved, among other things, as demonstrated above, that the external stimulating agent acts continuously in the process of orientation. Until this is done Loeb's statement that orientation is a function of the constant intensity must be classified as anthropomorphic speculation. And if the statement of my critic is true, that my investigations afford about as good support as has been furnished for Loeb's theories, it is evident that they rest on extremely nebulous foundations. If Holmes can produce a single case in which he can prove that orientation occurs in accord with any of these theories I trust that he will do so in answer to my reply to his criticism.

My discussion concerning certain theoretical views held by Jennings brings out the most caustic criticism that Holmes has to offer. He quotes the following paragraph from my book:

Every step in the development of the theory [Jennings] is supported by numerous experimental facts and all seems to fit what is known concerning the reactions of organisms. Reactions, according to this theory, are, as stated above, primarily due to physiological states. External agents ordinarily produce reactions through the effect they have on these states. By the application of this idea all the different phenomena connected with reactions to light as summarized at the beginning of this chapter can be accounted for.

This quotation is followed by a paragraph containing the following sarcastic remarks (p. 966):

It would indeed be comforting to be able to repose with such a spirit of confidence and contentment in a general philosophy of behavior, but it is perhaps pertinent to enquire if the author has not been deceived with the delusive appearance of explanation where no real explanation has been given. . . . Phenomena may thus be "accounted for" on the basis of varying internal states, but as it is admitted that in most cases we are entirely ignorant of what these states are we are about as much enlightened as we are by the celebrated explanation of the sleep-producing effect of opium by attributing it to a dormitive principle.

If I had said nothing more than is contained in the paragraph which Holmes quoted from my book there might be some excuse for such criticism, but the very sentence following this paragraph reads:

But what are these physiological states and of what do they consist? That there are such states in organisms can not reasonably be doubted, and that the reactions are dependent upon them much as Jennings assumes, seems to me to have been well established in his work. But what regulates the physiological states is a question concerning which we have as yet but little knowledge.

The two pages in my book following this quotation are devoted to an attempt to illustrate the limitation of Jennings's ideas, and it is concluded (p. 375):

For all that is known to the contrary, subjective factors, entelechies, or psychoids, factors foreign to inorganics, may have a hand in controlling physiological changes and consequently the reactions. Such factors have been postulated by the vitalists and neovitalists, notably by Hans Driesch.

I am at a loss to know how my critic could have read even superficially these statements and the argument connected with them and still conclude that I had been deceived with the delusive appearance of explanation where no real explanation has been given. I am not certain what Holmes means by a real explanation, but I am certain that neither Jennings nor I has ever even so much as intimated that the demonstration that reactions

of organisms are dependent in a definite way upon internal states constitutes a complete explanation of behavior. In the paragraph which Holmes singled out for attack with reference to this question I did not even use the term explanation, merely stating that the reactions could be "accounted for" by the application of certain ideas regarding internal states. Thus it is evident that his caustic criticism is directed not toward anything actually stated, but toward an imaginary implication.

However, to intimate as Holmes does in the second quotation given above, that a demonstration of the actual value of internal factors in behavior is useless because it is not known precisely what the internal factors are, is expressing a principle which if applied generally would at once do away with scientific investigation, for is it not well known that science in all of its aspects rests upon phenomena which are clothed in mystery? A scientific explanation, as I see it, consists of a demonstration of the order of events involved in the phenomenon. The demonstration that in the observed phenomena known as behavior events within the organism occur in a certain order in the whole series of events ending in these phenomena (behavior) is as truly an explanation as any we have in science. It is one step in the series, even if only a small one, which, as far as can be predicted at present, leads back into the unknown without end.

I can understand the statements of Holmes in his criticisms only on the assumption that he reviewed my book hurriedly and carelessly. As evidence of this we have not only his erroneous conceptions regarding Loeb's definition of tropism and his failure to grasp my ideas in the discussion of the theoretical views of Jennings, but also the fact that in his short quotation from my book there are three changes from the original. Moreover, his statement (p. 965) that I have presented "no discussion of any theoretical attempt to explain the reversal of phototaxis" is not true, as reference to page 370 will show.

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SCIENTIFIC BOOKS

Commercial Geography. By ALBERT PERRY BRIGHAM. Boston, Ginn & Co. 1911. 28 chapters, 449 pages, 17 colored maps and 253 illustrations. \$1.30.

This latest addition to the texts of commercial geography will very rapidly prove its worth because of the practical pedagogic principles followed in the arrangement and presentation of the material.

The great raw materials of world-wide interest and of vast significance in the commercial world are concretely presented, as Part I, in a series of chapters on wheat, cotton, cattle, iron and coal. A study of the activities centered about each of these great raw materials gives the student a broad outlook and furnishes a basis for Chapter VI. on the Principles of Commercial Geography. The discussion of raw materials before the considerations of the geographic principles will be welcomed by educators as far superior to the usual broad generalizations concerning a conglomerate hodgepodge of land forms, climate, rivers, lakes, raw materials, transportations and industry. Chapter IV. on Iron is typical of the method in which this text presents all of the five great raw materials. This chapter has excellent views, diagrams, maps and graphs.

The five types of raw materials are followed by the discussion and application of the principles to the United States which forms Part II. of the text. This presents in eleven chapters the physical features; plant, animal and mineral industries; water resources; transportation; commerce; centers of general industry and the concentration of industries. The space given to the United States is more than the average text, but this added emphasis is in accord with the general movement among educators to require from students a better understanding of our own country. The maps of production are especially clear and are constructed so that a comparison of various states and regions is very easy. The water resources of the United States is a chapter not generally considered in a commercial geography, but it

makes a most valuable addition. The concentration of industries and the centers of general industry is another innovation which is most heartily endorsed by instructors as excellent material well designed for instruction in modern commercial geography.

The foreign countries receive a brief but ample discussion for high school students. In each of the countries the proper emphasis is given the predominant industry of each individual country. The final chapter on World Commerce is an excellent application of the geographic principles which have been developed in the previous sections of the text.

In the writer's opinion this text has many points of superiority which greatly strengthen the instruction in commercial geography.

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SOME EARLY PHYSIOGRAPHIC
INFERENCES

THE inferences of early travelers as to the physiography of a region are always interesting if the traveler is a good observer. The following references may not be new to some geologists, but they were new to the writer and seem worth publishing.

Wm. Darby in his "Emigrant's Guide," 1811, states that one of the branches of the St. Francois River "appears to have been an ancient outlet of the Mississippi" (page 139). Apropos of the same region, James Hall in his "Notes on the Western States," Philadelphia, 1833, says "About midway between St. Louis and the mouth of the Ohio, masses of limestone rock are seen on either side, which, though now unconnected, have the appearance of once having formed a continuous ridge crossing the river in an oblique direction" (page 47). Both these travelers, in looking across the southeast lowlands of Missouri, inferred general truths that, taken together, would form important links in the history so admirably worked out nearly a century later by Professor C. F. Marbut.¹

¹"The Evolution of the Northern Part of the

As Darby infers, the Mississippi formerly flowed west of its present channel. It was separated from the Ohio by an interfluvium, the remnants of which are the "continuous ridge" mentioned by Hall. By two successive captures the Ohio diverted the Mississippi; the final capture led the Mississippi through its present gorge where the "masses of limestone rock are seen on either side."

Henri Peyroux de la Condreniere, commandant at Ste. Genevieve from 1787 to 1796, was a man of considerable scientific ability. In one of his essays he maintains that the Great Lakes formerly discharged into the Mississippi by way of the Illinois River. He reasons that the valley is too wide and deep to have been eroded by the present Illinois River. Another reason quoted is not so well founded; the "vast alluvium" stretching along the Mississippi to the Gulf is also held to indicate a drainage from the Great Lakes. This conjecture is an interesting prelude to the work which has shown the extent and drainage of those great marginal glacial lakes that preceded the present Great Lakes. The quotation has been handed down by Brackenridge, the lawyer-traveler in his "Recollections of the West," second edition, Philadelphia, 1868 (page 241). He (Brackenridge) adds prophetically "At no distant day the labor and ingenuity of man will restore the connection between the Lakes and the Mississippi by means of an artificial channel."

F. V. EMERSON

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SPECIAL ARTICLES

HORNS IN SHEEP AS A TYPICAL SEX-LIMITED CHARACTER¹

SEVERAL years ago Wood (1905) published a note in which he showed that, in a cross between a Dorset Horn and a Suffolk (belonging to the Lowlands of Southeast Missouri," University of Missouri Studies, Vol. I., No. 3, 1902.

¹ Joint contribution from the New Hampshire Agricultural Experiment Station and the Station for Experimental Evolution, Carnegie Institution of Washington.

ing to a hornless breed of sheep), the male offspring all developed horns but the female offspring remained hornless. He showed further that in the F_2 generation hornless males arise, and these do not carry the determiner for horns, and horned females, but only when they have the determiner duplex. Bateson (1909, p. 173) has discussed these facts and drawn the conclusion: "Sex itself acts as a specific interference, stopping or inhibiting the effects of a dominant factor, and it is not a little remarkable that the inhibition occurs always, so far as we know, in the female, never in the male." He admits, however, the difficulty in distinguishing between this probability and the other possibility; viz., that the male provides a stimulating factor. Castle (1911, p. 102) concludes that the reason horns are more strongly developed in males than females is "the presence of the male sex-gland in the body, or rather probably some substance given off into the blood from the sex gland, favoring growth of the horns"; and he adds that if the male Merino sheep (in which, usually, the male, and the female only is horned) is castrated early in life no horns are formed. He gives no reference for the last statement; and in view of the variability of the horned condition in the males of the "Merinos" the conditions of the experiments would have to be carefully considered before such a result could be accepted as settling the question of the dependence of horns in heterozygous males upon a secretion from the testis.

The hypothesis that we have adopted and which works with entire satisfaction assumes, first, that, as in man so in sheep, the male is heterozygous (simplex) in sex. One sex-chromosome is then to be expected in the male, and substantially this condition has been found to hold for man by Guyer (1910). The female will then be duplex in respect to sex. One further assumption is necessary; there is an inhibitor to horn formation, and this is located on the sex chromosome; consequently it is simplex in the male and duplex in the female. Thus it belongs to the well-known class of sex-limited characters. The inhibi-

Determiners in Germ Plasm of		No. of Horned and Hornless Offspring			
Male	Female	Males		Females.	
		Horned	Hornless	Horned	Hornless
Soma $XxhhIi$ (hornless).....	$XXhhII$ (hornless)				
Gametes XhI	XhI				
	xhi				
Zygotes $XxhhIi$ (hornless).....	$XXhhII$ (hornless)	0	4	0	12
Soma $XxhhIi$ (hornless).....	$XXHhII$ (hornless, simplex)				
Gametes XhI	XHI				
	XhI				
Zygotes $XxHhIi$ (horned).....	$XXHhII$ (hornless)	(2)	(2)	(0)	(2)
	$XxhhIi$ (hornless).....	2	2	0	2
Soma $XxhhIi$ (hornless).....	$XXHHII$ (horned)				
Gametes XhI	XHI				
	xhi				
Zygotes $XxHhIi$ (horned).....	$XXHhII$ (hornless)	15	0	0	24
Soma $XxHhIi$ (horned, simplex).....	$XXhhII$ (hornless)				
Gametes XHI	XhI				
	XhI				
	xhi				
Zygotes $XxHhIi$ (horned).....	$XXHhII$ (hornless)	(.5)	(.5)	(0)	(8)
	$XxhhIi$ (hornless).....	0	1	0	8
Soma $XxHhIi$ (horned, simplex).....	$XXHhII$ (hornless, simplex)				
Gametes XHI	XHI				
	XhI				
	xhi				
Zygotes $XxHHIi$ }.....	$XXHHII$ (horned)				
$XxHhIi$ } (horned).....	$XXHhII$				
$XxHhIi$ }.....	$XXHhII$ } (hornless)	(7.5)	(2.5)	(2)	(6)
$XxhhIi$ (hornless).....	$XXhhII$ }	6	4	1	7
Soma $XxHhIi$ (horned, simplex).....	$XXHHII$ (horned)				
Gametes XHI	XHI				
	XhI				
	xhi				
Zygotes $XxHHIi$ (horned).....	$XXHHII$ (horned)	(10)	(0)	(4)	(4)
	$XxHhIi$ (horned).....	10	0	4	4
Soma $XxHHIi$ (horned).....	$XXhhII$ (hornless)				
Gametes XHI	XhI				
	Hhi				
Zygotes $XxHhIi$ (horned).....	$XXHhII$ (hornless)	5	0	0	8
Soma $XxHHIi$ (horned).....	$XXHHII$ (horned)				
Gametes XHI	XHI				
	xhi				
Zygotes $XxHHIi$ (horned).....	$XXHHII$ (horned)	6	0	14	0

tor, then (designated in the table by the letter I , its absence by i), will always be double in the female and single in the male and, in the gametes, will always be associated with the sex-chromosome, which is designated throughout by the symbol X ; its absence by x . In the zygote the single inhibitor is incapable of preventing the development of the determiner

for the horn (H) even when the latter is only simplex. But the double inhibitor is capable of preventing the single horn (Hh) determiner, but not the double determiner (HH).

The table gives a summary of matings used, their hypothetical somatic and gametic composition, and the proportion of each sort of zygote that will be formed in each sex.

The actual frequency of offspring derived from each mating is given on the left of the table; the expected proportions in the more complex cases being given above the actual findings in parenthesis. The matings were made and the offspring examined in major part at the New Hampshire Agricultural Experiment Station and in minor part at the Station for Experimental Evolution. The latter station was able to contribute especially to the results of later generations. For horned females, Dorsets were used; for horned males Rambouilletes, Dorsets and the Scottish 4-horned race. As hornless races the Downs were chiefly employed. It is not our purpose now to give complete details, as the experiments are being continued and full data will be deferred until the publication of our final report.

The results of the table accord very closely with expectation, so that we are justified in concluding that an explanation of the results like that we offer is the correct one. By our formula, then, the case of inheritance of horns in sheep is brought quite into line with that of other sex-limited characters, its peculiarities being due to an inhibitor of horn development that is carried in the sex-chromosome.

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T. R. ARKELL,
C. B. DAVENPORT

DURHAM, N. H.,
COLD SPRING HARBOR, N. Y.,
January 29, 1912

THE "STOMACH STONES" OF REPTILES

GASTROLITHS have been known to occur, mingled with the remains of extinct reptiles,

for many years and much attention has been called to them in the pages of SCIENCE and elsewhere, especially by Mudge, Seeley, Williston, Eastman, Wieland and Brown. Interesting parallels have been cited among several living vertebrates. There has been some contention that the stones were taken for the purpose of a "gastric mill," but they were in part at least accidental. There seems to be some evidence for the conclusion that the plesiosaurs, at least, selected stones for this purpose, though this may have been more accidental than we think. Recently there has been brought to my attention by Mr. Edward Taylor, of the University of Kansas, an interesting case of stone swallowing by a lizard, *Phrynosoma cornutum* Harlan. Only a single specimen is at hand for the data, but it is of sufficient interest in connection with identical habits among fossil reptiles to be recorded. The horned "toad" in question is a very large adult female collected by the late Dr. F. H. Snow in the Magdalen Mountains of New Mexico. In the stomach were twenty large, somewhat abraded stones of a rock which resembled lava. Some of the stones are very large, for the size of the animal, measuring nearly a third of an inch in diameter. There were also in the stomach about 200 of the large red ants, of an undetermined species, which make the large mounds so common to the western traveler. The animal had undoubtedly picked up the stones with the ants from the top of the mound and the association is probably accidental. That they served the purpose of a "gastric mill" once inside the digestive canal can not be doubted, whether the animal willed or no.

In this connection it may be of interest to the readers of these pages to call attention to some large Cretaceous sharks which have, within the past few months, been received at the University of Kansas Museum. In one specimen, consisting almost entirely of scattered vertebral cartilages, there are associated many hundreds of greatly abraded, very smooth and polished stones of white and black quartzite. That they belong with the shark can not be doubted on account of the

association. The pebbles resemble to a great extent those figured by Dr. Williston some years ago as occurring with a pleisosaur. Another, nearly complete skeleton of a large shark, *Isurus mantelli* Ag., has preserved the larger part of the cranial cartilages. The sharks will shortly be described in detail and further reference need not be made to them here.

ROY L. MOODIE

THE UNIVERSITY OF KANSAS,
January 26, 1912

THE WASHINGTON MEETING OF THE
AMERICAN CHEMICAL SOCIETY¹

THE meetings of the society were held from Wednesday, December 27, to Saturday, December 30.

On Wednesday morning four papers were presented in joint session of the Section of Chemical Education and the Division of Physical and Inorganic Chemistry:

A. A. NOYES (chairman): *The Teaching of Physical Chemistry.*

W. D. BANCROFT: *Physical Chemistry in the Introductory Course.*

In the introductory course we should include: gas law; boiling-point curve; solubility; a brief statement of the dissociation theory; qualitative mass law, and qualitative catalysis. We should exclude: quantitative mass law; dilution law; solubility product, and reaction velocity. I am doubtful about electrolysis and osmotic pressure; but I should include the former and exclude the latter.

H. C. JONES: *The Introduction of Physical Chemical Conceptions in the Early Stages of the Teaching of General Chemistry.*

J. HOWARD MATHEWS: *Some Applications of Color Photography in the Teaching of Physical Chemistry.* (Illustrated.)

The theory and manipulations of the "screen-plate" processes of color photography were described briefly. Numerous scientific applications of color photography were pointed out, and each application was illustrated by color photographs thrown on the screen. The process has been found to be exceedingly useful in photographing inter-

ference figures and in recording the interference colors observed when certain crystals are viewed in polarized light. In many of the slides illustrating the latter, selenite plates were used to produce backgrounds of strong contrast and brilliant color. Photographs of "thin-sections" of various rocks showing their characteristic appearance in polarized light were also shown. The process has been found to be particularly well adapted to the projection of spectrum charts, etc., in colors. The absorption bands of chlorophyll were photographed directly in the spectroscope and a fairly accurate record obtained. Pure spectrum colors are not truly rendered by the process, since the color is always dependent on the dyes used to color the starch grains. However, an attempt to photograph the fluorescence of solutions of fluorescein met with considerable success.

The following three papers were presented in general meeting on Wednesday afternoon:

PRESIDENT FRANKFORTER (Section C): *The Resins and their Chemical Relations to the Terpenes.*

To be published in SCIENCE.

H. P. TALBOT (chairman Division of Physical and Inorganic Chemistry): *Privileges and Responsibilities of the Chemical Analyst.*

A. L. VOGEL: *Ostwald's Proposed International Institute of Chemistry (chiefly bibliography and library practise).*

On Thursday evening two addresses were given in general session:

ALEXANDER SMITH (president American Chemical Society): *An Early Physical Chemist.*

Published in the issue of SCIENCE for February 1.

FRANK B. KENDRICK and H. E. HOWE: *Lantern Experiments on Reactions in Heterogeneous Systems.*

A series of lantern illustrations of the effect of temperature, pressure, concentration, surface, osmotic pressure, etc., on reactions in heterogeneous systems. Several adaptations of a Bausch and Lomb balopticon were described, including a modification of the Töpler "Schlieren" apparatus for projection and the use of the lantern as a photographic camera.

On Friday a symposium on Mineral Waters was held before the Division of Industrial Chemists and Chemical Engineers. Titles of papers presented before this important symposium were published in SCIENCE of January 12. The papers themselves together with the voluminous discussion will be featured in the March issue of the *Journal of Industrial and Engineering Chemistry*.

¹Most of these papers will be published in the *Journal of the American Chemical Society* or in the *Journal of Industrial and Engineering Chemistry*.

The following papers were presented before the various divisional meetings:

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

H. E. Barnard, *chairman*.

B. E. Curry, *secretary*.

H. E. BARNARD (chairman's address): *A Study of the Pollution of the Ohio River Bordering Indiana*.

During the summer of 1911, the Indiana State Board of Health made a comprehensive study of the condition of the Ohio River bordering Indiana. A chemical and bacterial laboratory was fitted up in a house boat in which samples taken each mile were analyzed. The chemical analysis included the estimation of nitrates, the estimation of nitrites, the estimation of chlorine, of oxygen consumed, the estimation of dissolved oxygen, the estimation of alkalinity and turbidity. The bacterial analyses: an estimation of the number of bacteria; the presumptive test for *B. Coli* and the differential test for *B. Coli* on every tenth sample.

The work, which extended over three months, established new data on the purification of flowing streams and is a valuable contribution to the knowledge of the character of the Ohio River. The report will not be completed for publication until the spring of 1912.

W. A. WITHERS and F. W. SHERWOOD: *A Modification of the Tiemann-Schulze Method*.

B. L. MURRAY: *Determination of Small Amounts of Caffeine—A Comparison of Methods*.

The author has compared the results obtained by the method of Görter and by that of Lendrich and Nottbohm, using coffee and coffee preparations as samples. It is shown that when only small amounts of caffeine, particularly when less than 0.5 per cent., are present the Görter method yields results 50 to 100 per cent. higher than those of the Lendrich and Nottbohm. The author believes the Lendrich and Nottbohm method preferable. About fifty analyses are tabulated, each with duplicate results.

W. H. ROSS and RAYMOND C. BENNER: *The Filtration of Soil Solutions. A New Filter for This and Similar Purposes*.

FERNAND BRUNSCWIG: *The Presence of Lead and Copper in Cream of Tartar and Tartaric Acid. Technical Methods to Purify these Products*.

J. B. BATHER: *The Forms of Phosphorus in Cotton-seed Meal*.

J. F. SNELL: *An Electrical Conductivity Test for Purity of Maple Syrup*.

The syrup is diluted with two volumes of water and the electrical conductivity measured at 25° C., with a Wheatstone bridge and telephone in the customary manner. The specific conductivity multiplied by 100,000 gives the "conductivity value." The test is simple and rapid.

Among 57 samples of genuine syrups from Quebec, Ontario and Vermont, only two samples (these two not market syrups) give conductivity values over 200. The minimum value found was 110, the syrup giving this being the one prepared under the supervision of the Vermont Agricultural Experiment Station, under such conditions as to give the malate of lime every opportunity to settle out. Values less than 120 were given by only 3 samples—all very light colored, high-quality goods. Genuine syrups may, therefore, be expected to give values between 100 and 200—Canadian syrups ordinarily between 120 and 200.

Syrups compounded of maple syrup with over 50 per cent. of its weight of an equally dense syrup made from granulated cane sugar give values below 100. Imitation syrups made from granulated sugar and artificial maple flavors give still lower values. Such gross adulterations with refined cane sugar are immediately indicated by this test.

JOHN STEWART: *A Brief Study of the Phosphorus Associated with the Matière Noire*.

This paper attempts to answer the question: Is the phosphorus in the *Matière Noire* organic or inorganic? Treatment of the soil with NH_4OH fails to extract any phosphorus. Partial removal of acid soluble phosphorus and complete removal of acid soluble phosphorus, followed in each case with NH_4OH extraction, gives ammoniacal solutions with practically identical phosphorus content; viz., approximately 0.0103 per cent. on soil. The conclusion is that all the phosphorus associated with the *Matière Noire* is organically combined. Practically all the iron and aluminum present in the *Matière Noire* are organic. Hydrolysis takes place during extraction with alkali and a large part of the phosphorus and some iron and aluminum are converted into inorganic forms.

Several precipitating reagents for separating inorganic phosphorus from organic were tried; but results were unsatisfactory.

EMMA CRANDAL: *The Composition of Free Oyster Liquid*.

Present data on the composition of the oyster is meager. The author has endeavored, by a

study of oysters and oyster liquor purchased in the open market, to establish factors which will be helpful in showing whether or not oysters have been floated or watered in transit. This she does by a study of the total solids, ash nitrogen, chlorine of both the free liquor and oyster meats and calcium content, immersion refractometer reading. The data obtained are not conclusive and further work is proposed in the hope that it may be possible to establish definite factors of composition.

H. E. BISHOP: *New Data on the Composition of Prepared Mustards.*

Prepared mustard is a paste composed of ground mustard seed with salt, spices and vinegar and should conform to certain standards of composition. The author, in the course of a study of prepared mustards, finds that they vary greatly in character. He has endeavored by determining certain factors, namely, total solids, ash, sodium chloride, acidity, starch, crude fiber, protein, etc., to gather data of value in determining whether prepared mustards are pure or adulterated. The author finds a great variation in composition. The data at hand are as yet inconclusive. Further work is proposed in the hope that new data, throwing additional light on the composition of mustards, will be forthcoming.

J. M. PRICE: *A Method for the Separation of the Seven Coal-tar Colors when Occurring in Mixtures.*

L. H. SMITH: *Altering the Composition of Indian Corn by Seed Selection.*

In 1896 the Illinois Agricultural Experiment Station began experiments with a variety of corn to alter the chemical composition of the corn by seed selection. Fourteen years of breeding have produced the following results: The protein content has been increased from 10.92 per cent. in the original, to 14.87 per cent. in the crop of 1910. At the same time by selecting in the opposite direction, the protein has been decreased to 8.25 per cent.

Even more striking changes have been produced in the oil content. In the original corn the percentage of oil was 4.70. After fourteen years selection for high oil a strain has been produced which carried 7.72 per cent., while the corresponding selection for low oil has resulted in a strain which contains 2.11 per cent.

J. F. BREAZEALE and J. A. LECLERC: *Influence of Reaction of Culture Medium on Root Development of Wheat Seedlings.*

J. A. LECLERC and B. R. JACOBS: *The study of True and Imitation Graham Flour.*

C. C. MOORE: *The Desiccation of Potatoes and the Uses of the Product.*

The desiccation of potatoes has been commercially developed in Germany, but the product has not been suitable for the manufacture of starch. Investigations have shown that a dried potato product can be prepared in a way suitable for starch manufacture. Owing to the greater degree of fineness to which the dried product can be reduced, over 90 per cent. of the starch can be separated in the usual washing and decantation methods, as against a recovery of 65 to 75 per cent. of starch when potatoes are ground in a fresh state.

P. A. YODER: *Marking of Porcelain and Silica Crucibles, etc.*

Consecutive numbers in platinum or china colors may conveniently and neatly be put upon porcelain or silica crucibles, etc., by use of rubber type.

To apply china colors, a sizing like "Fat Oil," is first stamped upon the crucible, the dry pigment then dusted on, and after the varnish has set, the excess brushed off and the crucible fired in a muffle at a red heat for an hour. Blacks, especially "Lettering Black," gave very satisfactory results and the numbers resisted treatment with hot nitric acid and alkali solutions.

CHARLES FOX: *Perilla Oil.*

P. E. BROWN and R. E. SMITH: *Bacterial Activities in Frozen Soils.*

It was found, in the course of an experiment conducted during the winter months of 1910-11, that bacteria which developed on synthetic agar plates, ammonifying, nitrifying, denitrifying and nitrogen-fixing species whose activities were tested by the beaker method, were alive and multiplied in frozen soils.

In explanation of this, the theory is advanced that when soils freeze the hygroscopic water remains uncongealed, because of the surface tension exerted by the soil particles on the film water, its normal concentration in salts, and its increased concentration occurring when the main body of soil water begins to freeze.

Temperature exerted more influence than moisture on the bacteria developing on the agar plates.

H. H. HANSON: *Report of Progress in a Study of the Maine Sardine Industry.*

This paper gives an account of the industry from the taking of the fish to the finished product in the can, mentions problems of economic interest to the packers and others of scientific importance. There are three important respects in which the Maine sardines differ from the foreign sardines, of which the French pack is recognized as the most desirable. First, the fish packed in France under the name sardine is the *Clupea pilchardus*, while the fish packed in Maine under that name is the *Clupea harengus*, two distinct species of the same family. Second, French sardines are packed in olive oil while the Maine sardines are put up in cotton-seed oil. Third, in handling the French pack the single fish is the unit and quality is at all times considered of paramount importance; while in handling the Maine pack the hog-head is the unit and quantity is always sought. The French sardine retails for from thirty-five to sixty cents per can, while the Maine sardine retails for the most part for five cents. The markets for these two grades seem to be well established.

Indications seem to point to the conclusion that swelled cans are caused for the most part by imperfect sealing, although in some cases it would seem as though the sterilizing process was not sufficient.

An important food of the sardines, known to the trade as "red feed" seems to cause rapid deterioration of the fish. This has been identified as a microscopic crustacean of the family Centropagidæ, called *Temora longicornis*. It has been suggested that auto-digestion induced by an enzyme peculiar to this crustacean may be responsible for the rapid deterioration, but it seems more likely from present knowledge of the subject that a methylamine is the cause. Investigation is still going on.

W. B. SMITH: *The Index of Refraction of the Mixed Acids of Fatty Oils.*

Determinations of the ratio between the refraction of oils and of their insoluble acids gave, for linseed, cod liver, soy bean, corn, rapeseed, cottonseed, peanut and olive oils, values between 0.9933 and 0.9942; and for lard, lard stearin, oleo oil, oleo stearin, cocoa butter, butter, palmit oil, coconut oil and a mixture of cottonseed oil and oleo stearin, 0.9923 to 0.9941.

These figures are shown to be in accord with calculations from published refractive indices and with the ratios of the refractions of fatty acids

and triglycerides. The ratio is little affected by the saturation of the acid, being about 0.9938 for stearin, olein, linolin and linolenin, but decreases with the lower acids, palmitin, 0.9922; laurin, 0.9905.

Some typographical errors in reference books are noted, and the published refractive index of the acids of olive oil is said to be low by about 0.0050.

B. H. KEFNER: *The Profitable Application of Chemistry to the Milling Industry.*

DIVISION OF PHARMACEUTICAL CHEMISTRY

B. L. MURRAY, chairman.

F. R. Eldred, secretary.

B. L. MURRAY (chairman's address): *Our Advances and Retrogressions in Pharmaceutical Chemistry.*

A. B. ADAMS and J. M. DORAN: *Smoking Opium: Its Manufacture and Chemical Composition. Exhibit—Samples and Smoking Offit.*

LINWOOD A. BROWN: *An Improved Method of Assay for Aromatic Sulphuric Acid.*

The total acidity is determined by direct titration, using phenol phthalein and $N/10$ KOH, after which the "free sulphuric acid" is determined by precipitation as $BaSO_4$.

From the $BaSO_4$ found is calculated the number of c.c. of $N/10$ H_2SO_4 equivalent thereto. This is subtracted from the number of c.c. $N/10$ KOH consumed by total acidity, the difference represents the acidity due to the ethyl sulphuric acid, and from this is calculated the equivalent amount of H_2SO_4 .

The U. S. P. method gives too low results, due to the fact that ethyl sulphuric acid is not entirely hydrolyzed on heating for four hours, while in this method the results are higher, closely approaching the theoretical amount of H_2SO_4 known to be present.

Comparative tables of results by the two methods are given.

H. C. HAMILTON: *Notes on Cannabis Indica.*

The paper reviews the more important publications on the chemistry and pharmacology of the drug and describes a process of obtaining a body which possesses high activity.

This substance was not examined chemically, but its physical properties and physiological reactions were investigated and described. It is similar to that of Wood Spivey and Esterfield known as Cannabinol, but is obtained by a different method. No chemical treatment was ca-

pable of separating it into an active and an inactive portion.

Physiologically it was found to produce the typical "Cannabis intoxication" with a smaller dose than any other derivative of the drug so far obtained.

The paper concludes with comments on the peculiarities of this drug, which apparently make it unreliable. This is shown, however, to be due largely to the characteristics of the person on whom the effects are observed and not often, as is commonly supposed, to the variability in the drug itself.

H. C. HAMILTON: *The Pharmacopœial Requirements for Cannabis Sativa.*

The U. S. P. requirements are such that commercial samples of this drug can rarely be used as official because the drug has so often passed to the fruiting stage before being gathered, while to specify that it must be grown in India results in excluding a drug of first class quality grown in other localities.

To remedy this it is suggested that the requirements be made partly chemical and partly physiological. *Cannabis Sativa* is botanically identical from whatever locality it comes. Moreover, the extract soluble in cold alcohol is the active part and the yield of this can readily be determined.

Since the yield of an extract of this character is one of the variable factors and its activity the only other factor of importance the proposal is that the standard for *Cannabis Sativa* be that it shall contain not less than 10 per cent. extractive soluble in cold 95 per cent. alcohol. Further, that this extract must react on susceptible dogs when administered internally in a dose of 10 mg. per kilo weight of the dog.

JOSEPH P. REMINGTON: *Progress on the Work of Revision of the United States Pharmacopœia.*

The American Chemical Society, having representation in the United States Pharmacopœial Convention, should be informed of the progress made from time to time in the work of revision. The sub-committee on scope have made their report and a tentative list of admissions and deletions has been printed in the public magazines and journals. The Pharmacopœia is a book of standards. The necessity for careful and thorough revision. Analytical chemistry the foundation stone in the building of reform structures. The influence of the Food and Drugs Laws on the United States Pharmacopœia. The plan of revision. The American Chemical Society invited by

the chairman to send comments, facts and suggestions to aid in the work.

A. D. THORBURN: *The Estimation of Morphine in Cough Syrups.*

A. ZIMMERMAN: *Laboratory Studies of Rennin.*

A study of the properties of this ferment, when prepared by different methods. The variation in the length of time required to curdle different specimens of milk by rennin and how this is influenced by the milk, according to the length of time it is kept after the milking. Standardizing rennin to use as a control in rennin assay, for more accurate results. The acceleration of the action of rennin upon milk by phosphoric acid. The effect of alkalis upon milk, causing a variation of the length of time required to curd milk by rennin. The influence of heat in changing the acidity of milk, kept for a varied number of hours after the milking.

C. M. PENCE: *The Bromine and Iodometric Methods for the Volumetric Determination of Cresol.*

Usual bromine methods for determination of cresol depends upon fixed conditions predisposing a previous knowledge on the part of the operator, and while they may be of service they do not satisfy the demand for a desirable method.

Tri brom o. and p. cresol brom compounds can not be formed in a manner analogous to the production of 2-4-6 tri brom phenol brom. Di brom cresol brom compounds are formed and finally tri brom phenol brom; however, o. and p. cresols can not be determined volumetrically by a conversion into these compounds.

Meta cresol is determined by a conversion into tri brom m. cresol.

O. and p. cresols from di iodo compounds and this reaction is made the basis of a method for their determination.

Meta cresol does not yield di iodo compounds under the same conditions; hence, cresol U. S. P. or any mixture containing m. cresol can not be determined by a volumetric iodine method.

L. E. SAYRE: *The Analysis of a Very Old Sample of Powdered Gelsemium Root.*

ATHERTON SEIDELL: *A Bromine-hydrobromic Acid Method for the Determination of Phenols.*

CHARLES BASKERVILLE and W. A. HAMOR: *The Impurities of Anæsthetic Chloroform and Methods for their Detection.*

The impurities which anæsthetic chloroform brings with it from the manufacturer ("organic impurities") and the oxidation products of chloroform and alcohol are considered chemically

and physiologically, and rigid methods are given for their detection and estimation. "The main impurities contained in American anæsthetic chloroforms are, besides water, impurities decomposable by sulphuric acid and traces of the oxidation products of ethyl alcohol." The comparative purity of various samples of chloroform is discussed, and the necessary precautions which should be taken by manufacturers to guard against contamination are given. It is pointed out that "serious results have occurred from the use of anæsthetic chloroform containing foreign substances, and (that) although the grades at present sold as chloroform for anæsthesia hardly contain impurities which can be held responsible *per se* for deaths which have occurred during narcosis, yet the presence of these may produce some, at least, of the disagreeable after-effects so often noticeable following the administration of some chloroform." Results are given which lend strong support to the view of the authors as to the nature of the oxidation of chloroform and as to the rôle of alcohol in preservation.

M. I. WILBERT: *The Influence of Patents and Trade-marks on the United States Pharmacopœia.*

J. B. WILLIAMS: *The Estimation of Morphine in Pills, Tablets, etc.*

Morphine is more soluble in a mixture of alcohol and chloroform than in either solvent alone.

The aqueous solution of the sample containing morphine is made alkaline and extracted with a mixture of alcohol and chloroform, the alkaloidal solution evaporated to dryness dissolved in volumetric acid and titrated. Estimations can be made in from 2 to 3 hours.

Comparative results with Thorburn's phenyl-ethyl alcohol method are in favor of the alcohol-chloroform method.

FRANK O. TAYLOR: *Note on Mastic and Sandarac.*
C. H. BRIGGS: *The Alcohol Requirement of the Pure Food and Drug Law and the Accuracy of Alcohol Assays of Pharmaceutical Preparations.*

To meet the requirements of the Pure Food and Drug Law, all pharmaceutical preparations must be assayed for alcohol. Alcohol assays are apt to vary for several reasons. Volatile oils and drug extracts tend to give low results.

A ruling to the effect that fluid extracts and elixirs could be labeled with the maximum content of alcohol is very desirable.

FRED. KLEIN: *A Laboratory Study of Vegetable and Mineral Oils.*

FREDERICK J. AUSTIN: *Comments on Tests of the U. S. Pharmacopœia—Eighth Revision.*

Sets forth the discrepancies in the two tests for iron applied to copper sulphate, the apparent necessity of a time-limit in the test for absence of petroleum benzin, kerosene or similar hydrocarbons in oil of turpentine, the necessity of using larger amounts of hydrochloric and nitric acids in determining whether these acids are sufficiently free from arsenic for reagent use, and the unreliability of the U. S. P. test for absence of oxychloride in solution of iron chloride as an indication of whether it is suitable for use in making the U. S. P. tincture of iron chloride.

R. NORRIS SHREVE: *Suggested Modifications to the U. S. P. Assay of Opium.*

Some samples of opium were cited in case of which the U. S. P. assay will not remove but about two thirds of the morphine. So it is suggested that a very vigorous mechanical agitation be given the opium, and that a test be applied to determine the completeness of the extraction of morphine.

It was shown that the U. S. P. alcoholic mother liquors retain up to 100 milligrams of morphine, and to determine this it is suggested that a blank precipitation be made on pure morphine.

To determine the purity of the crude morphine the Mallinckrodt reassay is recommended.

F. P. DUNNINGTON: *Some Unfamiliar Facts about Familiar Detergents.*

J. R. RIPPETOE and R. MINOR: *Colocynthin U. S. P.*
W. O. EMERY: *Estimation of Antipyrine in Acetanilid or Acetphenetidin Mixtures.*

W. O. EMERY: *Estimation of Codein in Acetanilid or Acetphenetidin Mixtures.*

L. F. KEBLER and C. H. KIMBERLY: *Standard for Tincture of Ginger.*

An examination of a number of samples of tincture of ginger also at times designated extract of ginger shows that there was a material variation. Tinctures of ginger from the best manufacturers were then purchased and examined. The Pharmacopœia gives a process for manufacturing this article but does not give a specific standard, neither is the variety of ginger to be employed indicated. The latter is interpreted to mean that any kind of ginger may be used. It was therefore decided to purchase representative available samples of the various gingers on the market and use them in the manufacture of tincture of ginger. A description of the samples together with their fineness is outlined in the paper. The preliminary

examination showed that the available samples of Calcutta and Japanese ginger were not of a character suitable for manufacturing the tincture. Tinctures were then made from all of the samples and it was found, as indicated by the analysis, that the Calcutta and Japanese gingers produced tinctures of inferior character. The standard arrived at was as follows: Specific gravity, 0.8200; alcohol, not less than 88 per cent.; non volatile matter, between 1.25 per cent. and 1.75 per cent.

E. O. EATON: *Estimating Small Quantities of Morphin in Mixtures.*

At the 27th annual convention of the Association of Official Agricultural Chemists, a method for determining small quantities of morphin in mixtures was presented.

The method in brief consists in extracting the morphin from the mixture by means of lime water which is subsequently treated with ammonium chloride, the morphin precipitated, removed with a chloroform-alcohol mixture and the morphin finally determined volumetrically.

During the past year, two mixtures and a sample of opium were submitted to several workers and the results and their observations recorded. In the case of the two mixtures, several workers' results agreed fairly well, but the results obtained with the opium were quite unsatisfactory.

A. G. MURRAY: *Estimating Small Amounts of Nitroglycerin.*

L. F. KEBLER: *Standards and Methods.*

In this paper attention was called to the necessity of carefully studying present available methods and standards. It has been found from time to time that the methods prescribed for arriving at a certain standard are defective and therefore unsuited for careful court work. Particular attention was called to the shortcomings of the present method for determining the alkaloidal content of henbane leaves. The method, as a rule, gives results below the actual content of alkaloidal matter.

The subject of standards was referred to and several specific cases quoted: For example, the standard for cannabis indica is prescribed as a product free from stone cells, which means virtual absence of seeds. Experience shows that it is practically impossible to find such a product on the market. Its enforcement, therefore, would be a most difficult problem. The question of arriving at a fair and just standard was also taken up and discussed fully. For example, the Pharmacopœia

prescribes a definite standard for hydrogen peroxid, but it is well known that this commodity is prone to decomposition and the question arose as to what amount of variation should be permitted before considering the article inferior. In order to determine this point, all of the available samples of hydrogen peroxid were purchased and examined by two different observers in several sections of the country. The observations were made during a period extending over one year, and it was found that there was no difficulty whatever in preparing this commodity so as not to fall materially below 15 per cent. of the prescribed standard within six months. If, therefore, a sample of hydrogen peroxid was found to be only one half the strength prescribed by the Pharmacopœia, it was either made by faulty methods or much more time than six months had elapsed since its preparation. Other examples were cited to show that it was absolutely necessary to use judgment and discretion even though the standard was prescribed.

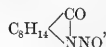
DIVISION OF ORGANIC CHEMISTRY

Geo. B. Frankforter, *chairman.*

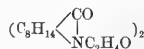
Wm. J. Hale, *secretary.*

WILLIAM A. NOYES and J. A. COSS: *The Decomposition of Nitroso Compounds.*

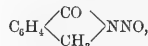
Some years ago Mr. Taveau, with one of us, found that on warming the nitroso derivative of the anhydride of aminolauronic acid,



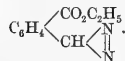
with an alcoholic solution of sodium hydroxide, a compound was formed to which the formula



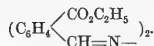
was assigned. A study of the similar decomposition of the nitroso derivative of phthalimidine,



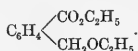
has shown that the primary product is a diazo compound of the structure



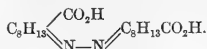
This decomposes, giving the compound



In the presence of alcohol it gives the ester ether



The first of these is, of course, the analog of the compound described by Mr. Taveau and the latter is the bishydrazone of camphonic acid,



HOWARD W. DOUGHTY: *Ortho- and Para-Tolueneselenonic and Tolueneseleninic Acids.*

NICHOLAS KNIGHT: *The Preparation of Certain Oxylactones.*

When phenyleyan pyroracemic acid ethyl ester is heated with sulphuric acid, the ester is hydrolyzed and water and carbon dioxide pass out of two molecules of the acid. The resulting product is an oxylactone of the formula $\text{C}_{11}\text{H}_{14}\text{O}_8$, which melts at 171° .

When a mixture of phenyl pyro racemic acid is allowed to stand some days with fuming hydrochloric acid the liquid becomes filled with fine needles which on crystallizing from alcohol is shown to be an oxylactone of the formula $\text{C}_{16}\text{H}_{18}\text{O}_8$. The melting point is 206° . A number of salts were made from this oxylactone.

J. U. NEF: *The Three Lactones d-Mannonic Acid and their Bearing on the Constitution of the Sugars and the Glucosides.*

TREAT B. JOHNSON: *The Action of Halogens on Tyrosinehydantoin.*

Methods have been developed for preparing easily 3,5-diiodo-, 3,5-dibromo- and 3,5-dichlorotyrosines. Bromine and iodine react smoothly with tyrosine, $\text{HOC}_6\text{H}_4\text{CH}_2\text{CH}(\text{NH}_2)\text{COOH}$, forming 3,5-dibromo- and 3,5-diiodotyrosines, respectively. 3,5-Dichlorotyrosine is not formed in an analogous manner by the action of chlorine on the amino acid.

Chlorine and iodine react with tyrosinehydantoin, forming the corresponding 3,5-dichloro- and 3,5-diiodotyrosinehydantoins, respectively. Bromine reacts abnormally with tyrosinehydantoin, giving 3,5-dibromobenzalhydantoin.

TREAT B. JOHNSON: *The Action of Potassium Thiocyanate on α -Amino Acids.*

The hydantoin derivatives of α -amino acids are well known, and of great value for the identifications of these acids. The corresponding nitrogen-unsubstituted 2-thiohydantoins, however, are not known. A practical method has now been developed by which representatives of this new class

of compounds can be easily synthesized. The 2-thiohydantoin derivatives of glycocoll and alanine have already been prepared.

The present communication is in the nature of a preliminary statement regarding the extension of this work to other α -amino acids, which has already been begun. The results indicate that this class of compounds will be of great value in helping us to develop other syntheses of biological significance.

CLARENCE G. DERICK: *Correlation of Ionization and Structure in the Aromatic Series.*

CLARENCE G. DERICK: *A New Proof of the Equivalency of the Pair of Positions 3 and 5, with Respect to Position 1, in the Benzene Ring.*

HARRY S. FRY: *A Critical Survey of some Recent Applications of the Electron Conception of Valence.*

ALVIN S. WHEELER: *New Thermometers for Accurate Melting-point Determinations.*

The thermometers are of the usual length but are graduated only at the lower end so that the graduations are completely immersed in the liquid of the ordinary melting-point bath, the Thiele for instance. There are seven in the set in order to cover the necessary range. They may be obtained of C. Richter, of Berlin, and standardized by the Reichsanstalt. They have met the approval of some very well known men.

ALVIN S. WHEELER: *The Walden Inversion.*

A model consisting of celluloid balls of various colors attached to corks covered with wire bristles designed to attach same to a large bristle-covered ball, the C atom, was exhibited to illustrate the theory propounded by Emil Fischer to explain the Walden inversion. The case studied by the author with Fischer was that of α -hydroxyisohexoic acid. This acid was split into its active forms, the *lævo* being obtained in pure condition. Its ethyl ester with PBr_3 yielded a bromo ester which was strongly dextrorotatory. But the *lævo* acid with NOBr gives a *lævo* bromo acid which yields a *lævo* bromo ester.

R. R. RENSHAW: *Studies in the Methods of Preparation of Diglycerides.*

The reaction between salts of stearic acid and 1,2-dibrom and diiodhydrin have been investigated between the temperatures of 180° and 200° . There is formed stearic acid, distearin tristearin and small amounts of a compound containing bromine and stearic acid. Good yields were never obtained. The use of the lead salt seems to be preferable.

At slightly above its melting point dibromhydrin dissociates completely into two molecules, hydrobromic acid and probably epibromhydrin.

Pure 1, 2-dilaurin, diisovalerin and diacetin have been obtained.

R. R. RENSHAW: *Investigation of Choline and its Derivatives*. (Third paper.)

By the action of phosphorus oxychloride on choline chloride there has been obtained a highly hygroscopic, unstable chlorcholine phosphoric acid dichloride.

Experiments on the stability of choline salts have been carried out both by physiological and chemical tests. Pure choline salts give a lowering of the blood pressure. Choline chloride is not a very unstable salt. It can be preserved without decomposition into trimethyl amine or neurine.

WILLIAM J. HALE: *The Formation of Nitropyrimidines*.

CHAS. H. HERTY and C. S. VENABLE: *The Schkate-loff Method for Reduction and Precipitation of Resin Acids*.

CARL O. JOHNS: *On 2-Oxy-1-Methylpurine*.

The potassium salt of 2-oxy-5-nitro-6-aminopyrimidine was heated with methyl iodide and a mono-methyl derivative was obtained. The position of the methyl group was ascertained by converting this compound into 2, 6-dioxy-3-methyl-5-nitropyrimidine. When 2-oxy-3-methyl-5-nitro-6-aminopyrimidine was reduced with ferrous hydroxide it gave 2-oxy-3-methyl-5, 6-diaminopyrimidine, which in turn gave a formyl derivative the potassium salt of which, when heated, formed the potassium salt of 1-methyl-2-oxypurine. The free base crystallized with 2 molecules of water. The picrate decomposed at 214° C.

CARL O. JOHNS: *On 2-Oxypurine and 2-Oxy-8-Methylpurine*.

2-Oxy-5, 6-diaminopyrimidine was heated with formic acid and a monoformyl derivative was produced. The potassium salt of this compound liberated water when heated and the potassium salt of 2-oxypurine was produced. The free base crystallized with one molecule of water and the crystals were stable at 110° C., but the water escaped at 130° C. The picrate decomposed at 245° C.

Acetic anhydride reacted with 2-oxy-5, 6-diaminopyrimidine and the chief product was a mono-acetyl derivative. The potassium salt of this was heated and the potassium salt of 2-oxy-8-methylpurine was obtained. The nitrate decomposed violently at 205° C. and the picrate at 250° C.

M. L. CROSSLEY: *A New Derivative of Anthroquinone*.

M. T. BOGERT and M. HEIDELBERGER: *Phthalones in the 4-Quinazoline Group*.

2-Methyl-4-quinazoline condenses smoothly with phthalic anhydride to the symmetrical phthalone, which behaves as a weak acid, forming a yellow mono-sodium salt and a red disodium salt, as well as a red mon-anil, a mono-phenylhydrazine and a sulfonic acid. Energetic reduction converts the phthalone into the corresponding hydrindone. Bromination of the sulfonic acid of the phthalone in aqueous solution yields a dibrom 2-methyl-4-quinazoline, which is not the 6, 8-dibrom compound, a pentabrom 2-methyl-4-quinazoline, a monobrom 2-methyl-4-quinazoline sulfonic acid, phthalic and sulfuric acids. An interesting feature of the reaction is that the bromine splits the phthalic acid off from the quinazoline.

6-Nitro and 7-acetamino 2-methyl-4-quinazoline condense similarly to phthalones. With phthalimide, the 2-methyl-4-quinazoline condenses to the unsymmetrical, or beta, phthaline, with formation of a small amount of what appears to be a bis-quinazoline phthaline.

2-Methyl-4-quinazoline and succinic anhydride react vigorously with production of a tarry mass, from which a colorless anhydro body may be isolated.

2-Methyl-4-quinazolones carrying alkyl groups in position 3 either refuse to condense with phthalic anhydride or give but small yields of phthalone.

In none of the experiments was the formation of any isophthalone observed, nor could we isolate any intermediate products except the phthalate of the quinazoline.

Like the quinophthalones, these phthalones act as yellow dyestuffs, but in tinctorial power they seem inferior to the former.

M. T. BOGERT and G. A. GEIGER: *On Certain New Quinazolines*.

The following new 4-quinazolones have been isolated and studied: 3-ethyl; 3-benzyl; 2-methyl-3-p-nitrophenyl; 2-methyl-3-p-tolyl; 2-methyl-3-alpha naphthyl; 2-methyl-3-beta naphthyl; 6-nitro; 6-amino; 6-acetamino; 6-nitro-3-methyl; 6-amino-3-methyl; 6-acetamino-3-methyl; 6-nitro-3-ethyl; 6-amino-2, 3-dimethyl; 6-nitro-2-methyl-3-ethyl; 6-amino-2-methyl-3-ethyl; monobrom and brom-2-methyl.

The 3-methyl-4-quinazoline of Knape (m.p. 71°) carries a molecule of water of crystallization, the pure anhydrous substance melting at 105°.

Nitration of 2-methyl-3-phenyl-4-quinazoline with a mixture of concentrated sulfuric and fuming nitric acids gives a dinitro derivative; by similar treatment of 2-methyl-3-p-nitrophenyl-4-quinazoline, only one nitro group is introduced; but these two dinitro derivatives are not identical. Nitration of 2-methyl-3-p-tolyl-4-quinazoline also gives a dinitro derivative. The action of nitric acid, in presence of metallic mercury, upon 2-methyl-4-quinazoline gives only the mercury salt of the latter, whereas with quinoline a nitro-hydroxy derivative is produced.

The 4-quinazolones are not readily brominated, but by the Javalta process bromine derivatives may be obtained.

M. T. BOGERT and G. A. GEIGER: *On Quinazoline Iodomethylates*.

Iodomethylates, and other iodoalkylates, have been prepared from a large number of quinazolines, and the following general conclusions are drawn from the experiments:

1. 4-Quinazolones add alkyl iodides generally only under pressure at about 110°.

2. The alkyl iodide adds to the N adjacent to the benzene nucleus (*i. e.*, the N in position 1 in the quinazoline nucleus) and not to the N in position 3, since the compounds obtained by adding methyl iodide to 2-methyl-3-ethyl-4-quinazoline and ethyl iodide to 2, 3-dimethyl-4-quinazoline are not identical.

3. The iodoethylates are more soluble in water, and in methyl alcohol, than the iodomethylates.

4. By the action of methyl iodide alone, in excess, 4-quinazoline, 3-methyl-4-quinazoline and 4-methoxyquinazoline, all give one and the same product, namely, the iodomethylate of 3-methyl-4-quinazoline.

5. Many of the nitro 4-quinazolones refuse to combine with methyl iodide.

6. Styryl 4-quinazolones add methyl iodide more readily than ethyl iodide, but certain groups in position 3 appear to prevent the combination even with methyl iodide.

7. By the action of silver nitrate upon some of these iodomethylates, corresponding methyl nitrate addition products have been obtained.

M. T. BOGERT and L. E. WISE: *On p-Aminobenzonitrile*. (Third paper.)

The following additional compounds have been prepared and studied: p-aminobenzonitrile picrate, p-cyanoxanilamide, oxanilic p-cyananilide, p-cyan-succinanilic acid, its silver salt, methyl and ethyl

esters, and anil, p-cyanphthalanilic acid and its anil, p-cyanphenylurethane, p-caramido phenylurethane, p-cyanphenyl urea, carbanilic p-cyananilide, p-cyananilide, methylene di(p-cyanphenamine), 3-nitro-4-acetamino benzamide and 3, 4-di-acetyldiaminobenzonitrile.

The nitrile appears to add a molecule of chloral directly, and then on dehydration gives the trichlorethylidene di-p-cyanphenamine.

Bromination of the acetamino nitrile, like nitration, gives the mono substitution product.

From 3, 4-diaminobenzonitrile, the 3-cyan-alpha-methyl benzimidazole can be obtained as well as the corresponding amide.

M. T. BOGERT and G. D. BEAL: *A Further Study of the Stilbazoles, Hydrazones and Schiff Bases in the 4-Quinazoline Group*.

In the condensation of aldehydes with alpha-methyl pyridines or quinolines, the alkynes evidently form easily and are often so stable that considerable difficulty is experienced in dehydrating them to the stilbazoles. With these quinazoline condensations, on the other hand, the alkynes either do not form at all or are so unstable that they immediately lose water and give the stilbazole. Neither hydrogen nor bromine can be added to the double bond of these stilbazoles, but bromine gives rise to substitution products.

A large number of new aldehyde condensation products were prepared of the above types. Most of the styryl quinazolones are pale yellow and crystallize in fluffy masses of short silky needles. Often they show strong tribo-electric properties. Those with a free hydrogen atom in position 3 usually dissolve readily in solutions of the caustic alkalies and are reprecipitated by carbon dioxide.

Incidentally, a number of new quinazolines were prepared by condensing various amino bodies with acylantranils, and certain of them were tested with reference to their physiological effect upon animals.

Under the conditions of our experiments, the group which reacted most readily with aldehydes was the 3-amino group, then the 2-methyl, then the 7-amino, while the 2-amino refused to condense at all. Benzaldehyde proved much the easiest aldehyde to condense with these groups, often reacting when all other aldehydes tried failed.

M. T. BOGERT, R. A. GORTNER and A. H. KROPPF: *On Certain New Dyestuffs*.

By condensation of acylantranils with aromatic primary diamines, new amine bases result which can be used for the production of dyestuffs

in much the same manner as the anilines or naphthylamines.

This paper describes only certain of the azo dyes obtained from these new quinoxaline bases, together with a few other related dyestuffs. The dyes described are (A) those obtained by diazotizing aminoquinoxalines, with the amino group either on the benzene or on the triazine portion of the nucleus, and coupling with various well-known couplers; and (B) those obtained by using these new bases themselves as couplers for the ordinary diazo salts.

Monazo and polyazo dyestuffs can thus be produced in infinite variety. Those obtained from acylamino acylantranils may be de-acylated and the liberated amino group again diazotized and coupled.

These new dyes include direct dyestuffs for cotton, as well as for wool and silk. Many are fast to light, acid or alkali, washing and milling, bleaching, etc.; they penetrate the fiber well and give level dyeings.

WM. MCPHERSON and CECIL BOORD: *The Preparation of Orthoquinones with Complex Side Chains and Their Reactions with Hydrazines.*

E. K. MARSHALL, JR., H. C. ROBERTSON, JR., and Miss J. PEACHY HARRISON: *On the Mechanism of the Reactions of Ethylates with Alkyl Halides.*

N. E. LOOMIS, C. N. MYRES and S. F. ACREE: *The Use of the Hydrogen Electrode in Organic Chemistry.*

RALPH H. MCKEE: *The Preparation of Sulfonic Acids.*

The process of sulfonating aromatic hydrocarbons can be greatly facilitated by the use of vigorous stirring, *e. g.*, cymene with slightly more than its own volume of sulfuric acid (sp. g. 1.42) gave at room temperature in twenty minutes complete sulfonation, where by the use of infusorial earth it requires several days, or shaken by hand on the water bath with much excess of acid it requires a number of hours. The stirrer used rotated 900 times a minute.

Paraffin hydrocarbons, the portion boiling about 200° from ordinary kerosene, stirred with ordinary sulfuric acid at room temperature was partially attacked to give a disulfonic acid. With the fuming acid the hydrocarbon was all attacked with formation of a mixture of sulfonic acids and oxidation products. Strong nitric acid by similar treatment also attacks the paraffin hydrocarbons at ordinary temperature, but the products formed have not as yet been analyzed.

The distinction between the hydrocarbons of the benzene and methane series toward sulfuric and nitric acids shows evidence of being due in large part to the less solubility of the paraffin hydrocarbons in acids rather than to an essentially different chemical character, *i. e.*, the difference is in part one of physical properties (solubility) rather than one of chemical properties.

I. K. PHELPS: *The Preparation of Cyanacetic Acid in Quantity.*

BIOLOGICAL CHEMISTRY SECTION

Carl L. Alsberg, *chairman.*

I. K. Phelps, *secretary.*

W. M. CLARK: *Gases of Swiss Cheese. II.*

Since the gas formed in Emmentaler cheese is the immediate cause of the formation of the characteristic "eyes," it was hoped that data concerning the gases produced would aid in diagnosing the bacteria which are thought to be responsible for the development of the eyes.

For this purpose apparatus was devised for collecting the gases found in the "eyes" and in "pin holes" and the body of the cheese. It was found that the gas of normal eyes consists largely of CO₂ and nitrogen. Hydrogen is sometimes present in very small percentages. The abnormal production of gas which takes place frequently the first day was found to be accompanied with large percentages of hydrogen.

The gas produced by normally developing cheese during the period of its maximum eye-formation was found to be chiefly CO₂.

The absorption of oxygen was studied as well as the permeability of cheese to different gases.

In the light of all the facts thus gained a discussion is made of the interchange of gases and of the relation of these to theories concerning the formation of the eyes.

L. W. FETZER: *The Cholesterol Content of Milk under Normal and Pathological Conditions.*

From this work it can be noted that a decrease in the cholesterol content of milk takes place under pathological conditions, and where a decrease in cholesterol content was noted there was a corresponding decrease in the fat content. If, however, the cholesterol content was compared with the milk fat on the basis of 100 parts of ether extract, then the cholesterol seemed to be increased.

J. P. ATKINSON: *Quantitative Results of Certain Poisonous Metals and Alkaloids after Digestion of their Enveloping Tissue in Artificial Gastric Juice.*

E. D. CLARK and F. J. SEAVER: *Studies on Soils Subjected to Dry Heat.*

In the present paper we have extended to the green plants our earlier observations of the effects of heated soils upon the growth of fungi. Different degrees of dry heat give soils whose aqueous extracts have a brown color the depth of which is proportional to the intensity of the heat. The amount of soluble matter, organic, inorganic, nitrogen, etc., was also proportional to the different temperatures (90° to 180° C.). The dark extracts from strongly heated soils were favorable for fungous growth but were distinctly unfavorable to Lupin seedlings grown in them; this inhibiting action being greatest in the darkest colored extracts. Oats sown in a series of soils heated to different temperatures showed a slight stimulation for the temperature up to 125°, when compared with the unheated soil as a control; while above 125° the heated soil had a very toxic effect. The organic matter of the darker extracts gives nearly all the tests for reducing sugars, is largely precipitated by acetone, smells like caramelized sugar, and has a strong acid reaction to litmus.

R. H. JESSE and EDWARD BARTOW: *Composition of Gases Formed by the Decomposition of Organic Matter.*

We were called upon to investigate the cause of an explosion of gases in a septic tank at Highland Park, Illinois. In trying to trace the cause of this explosion we collected and analyzed gases from several septic tanks. But little variation was found between the composition of the gases from the tank which exploded at Highland Park and the gases from other tanks in the central west. There was, however, a great variation between the composition of these gases and the reported composition of gases analyzed by other investigators. During the summer of 1911 samples of gases were collected and analyzed from tanks in Illinois, Columbus, Ohio, from Worcester, Massachusetts, and from the Illinois River below the mouth of the Drainage Canal. The greatest difference is seen in comparing the gases from Worcester with the gases from Illinois tanks. The gases from the Illinois River agree closely in composition with the gases from some of the septic tanks and differ very materially from a sample of gases collected from an unpolluted swamp. We have noted differences in gases taken from different compartments of the same tank and there is an apparent difference in gases collected below the upper sludge and in the bottom.

We feel that the results thus far obtained can only be regarded as preliminary to further study of the subject.

E. D. CLARK and R. A. GORTNER: *The Chromogen and Associated Oxidases in the Mushroom *Strobilomyces strobilaceus*.*

L. A. HAWKINS: *The Effect of Certain Chlorides Singly and Combined in Pairs on the Activity of Malt Diastase.*

R. A. GORTNER and E. D. CLARK: *The Chromogen and Associated Oxidase in the Mushroom, *Strobilomyces strobilaceus*.*

Upon injury the color change of this fungus is from white through pink to black, this action being a rapid one. We considered that this was a case of ordinary tyrosinase activity and it was only upon examining the material for another purpose that we learned that this assumption was not true. We were unable to detect the slightest trace of free tyrosin by any of the delicate color tests. However, we were able to make preparations of an oxidase from this plant that were very active in causing the oxidation of a tyrosin solution. Evidently, then, this fungus contains a tyrosinase or similar enzyme which oxidizes some other chromogen. This chromogen proved to be pyrocatechin or one of its derivatives, as shown by all the tests and methods at our disposal. The oxidase preparation produced exactly the same change in a solution of pure pyrocatechin that is noticed in the plant itself.

H. H. BUNZEL: *Biochemical Study of the Curly-top Disease of Sugar Beets.*

The paper gives results obtained in oxidase measurements on diseased and healthy beets, on leaves as well as roots, under the various conditions at different times of the day and various stages of development. The result obtained in greenhouse experiments, *i. e.*, that the diseased leaves have a higher oxidase content than the healthy ones, was confirmed in the field. The general result of all the experiments carried out, indicates that the oxidase content is higher in the leaves in all the cases where the normal growth of the plant has been interfered with, whether the retardation of growth is brought about by excessive drought, excessive watering of the soil, the curly-top disease or other diseases. The distribution of the oxidase in the leaves and roots of the plant was measured. Analyses of the samples collected simultaneously with the oxidase determinations are as yet not completed.

C. L. ALSBERG and O. F. BLACK: *Phytochemical Studies in Cyanogenesis.*

The relation between the nitrates in the soil, nitrification during drought and cyanogenesis in sorghum, based on experiments done at the Arlington Farm in the course of the past summer, is discussed and an incidental error in the common method of determining hydrocyanic acid in plants is pointed out.

C. L. ALSBERG and W. M. CLARK: *Notes on the Blood of Limulus polyphemus.*

P. A. YODER: *The Presence and Identification of Choline in Wheat and Cotton Seed Flours.*

OSWALD SCHREINER and J. J. SKINNER: *The Action of Nucleic Acid and its Decomposition Product on Soils and Plants.*

Nucleic acid as well as some of its decomposition products occur in soils and the effect of some of these compounds has been studied with wheat seedlings. Mineral nutrient solutions with phosphate, potash and nitrate in varying proportions were used, and to these were added 50 parts per million of the compound tested. The neutralized nucleic acid as well as its nitrogenous decomposition products, hypoxanthine and xanthine, had a beneficial action on the plants, promoting growth and decreasing the nitrate absorption. The plants appear to be able to utilize these compounds directly in their metabolism and require under these circumstances less nitrate for maximum growth.

M. X. SULLIVAN: *Origin of Creatinine in Soils.*

Of samples of the same soil planted and unplanted kept side by side in the greenhouse, the water and glycerine extracts of the planted soils gave larger amounts of creatinine by the creatinine zinc chloride method. It would seem that the increase in the amount of creatinine was connected in some way with plant growth. Creatinine was found in small amounts in the water in which wheat seedlings had grown, in wheat seeds, wheat seedlings, wheat bran, rye, clover, alfalfa, cowpeas and potatoes. Besides the possible production of creatinine by microorganisms and the introduction into soil in the animal excreta of stable manure, the creatinine of soils has its origin in vegetable matter.

EDMUND C. SHOREY: *Nucleic Acids in Soils.*

Nucleic Acids have been obtained from soils by extraction with dilute sodium hydroxide, neutralizing and concentrating under reduced pressure, acidifying with acetic acid and addition of several volumes of alcohol as a light-colored amorphous

body which on hydrolysis gave pentose sugars, purine bases, pyrimidine compounds, levulinic acid and phosphoric acid. Xanthine and hypoxanthine were identified among the purine bases and cytosine among the pyrimidine compounds.

AUBREY V. FULLER: *The Biological Oxidation of Sodium Arsenite in Solution.*

The author has shown that sodium arsenite in solution may undergo practically complete oxidation to arsenate through the agency of a micro-organism or—organisms as yet not identified. The organisms differ from the nitrifying bacteria of Winogradsky in that this activity is evidenced only in the presence of ordinary culture media, such as meat infusion.

G. A. RUSSELL: *The Effect of Mold on the Chemical Composition of the Fixed Oil from Brazil Nuts.*

C. F. LANGWORTHY and R. D. MILNER: *An Improved Form of Respiration Calorimeter and its Use for the Study of Problems of Vegetable Physiology.*

W. E. TOTTINGHAM: *The Influence of Bacteria on the Soluble Phosphorus of Manures.*

Relevant to a project embracing study of reactions between farm manure and reinforcing substances, such as feldspar, rock-phosphate and peat, investigation of fermenting manures has shown in all cases decrease of water-soluble phosphorus. Fermenting mixtures of manure and rock-phosphate have shown greater decreases than manure alone. A typical experiment with mixed cow and horse manure fermented six months without and with rock-phosphate (25 lbs. fresh manure and $\frac{1}{2}$ lb. rock-phosphate) involved 16.45 grams soluble phosphorus in the manure and 18.49 grams in the phosphate mixture at the start. The water-soluble phosphorus of the manure decreased from 86.7 per cent. to 65.6 per cent. of the total, a decrease of 24.3 per cent. of the original water-soluble phosphorus. The sample with phosphate gave a decrease from 34.3 per cent. to 14.7 per cent. of the total phosphorus, a loss of 57 per cent. of the water-soluble phosphorus. Common solvents for inorganic phosphates, such as carbonated water, ammonium citrate solution and $N/5$ nitric acid recovered the depressed phosphorus only partially.

Two and one half months standing with and without antiseptics produced the following changes of water-soluble phosphorus in manure-rock-phosphate mixture. Normal fermentation; decrease from 33.26 to 17.64 per cent. of total. Saturated with chloroform; decrease from 32.61 to 28.11 per

cent. Saturated with formaldehyde; decrease from 29.36 to 26.85 per cent. The losses amounted to 47.0, 13.8 and 8.5 per cent., respectively, of the water-soluble phosphorus. The results seemed to indicate that the losses observed were not due primarily to "reversion" of inorganic phosphates, but chiefly to bacterial activity.

Manure bacteria grown on media prepared from extract of fresh manure-rock-phosphate mixture reduced the soluble phosphorus of the media 23.8 to 63.6 per cent. Fresh intact bacterial cells of specific organisms and manure flora contained 34 to 53 per cent. of their phosphorus in water-soluble form. Drying in vacuo at room temperatures did not alter the solubility of the phosphorus appreciably. The residual phosphorus was partly recovered from crushed cells by water and did not appear especially resistant to 0.2 per cent. acid or alkali solvents. These results appear to point conclusively to bacteria as the chief cause of loss of soluble phosphorus in fermenting manures.

Further work is in progress with acid-phosphate and involving also the rôles of soil organisms and the plant in rendering phosphorus of manure bacteria available to crops.

JOHN H. LONG: *A Series of Complete Urine Analyses.*

This paper is a study of the urine of a number of men in normal health and on a protein diet amounting to from 70 to 88 grams daily. The results, presented in tabular form, embraced determinations of the bases calcium, magnesium, sodium, potassium and ammonium and the important acids present.

For each urine the various acid and basic ions present were reduced to the hydrogen equivalent and these results shown in tables. While there was an apparent excess of acid in each case it was shown that with proper consideration of the probable urate and phosphate combinations some of the urine should exhibit an alkaline reaction toward litmus, as was, in fact, the case.

The results are from the mixed aliquots saved from urines collected through a period of about 35 days, and embraced a study of the nitrogen and other factors as well as the acids and bases.

JOHN H. LONG: *Some Further Studies on the Composition of Feces Fat.*

Some years ago attention was called by the writer to the rather large amounts of organic phosphorus compounds found in the fat of feces studied in his laboratory. This is a continuation of these examinations, and analyses were made of

the fats from the feces of six men collected through long periods. These analyses embraced not only a determination of the phosphorus, but numerous other factors as well. The means of the results obtained show that the phosphatide content of the fat is larger than usually stated in works on physiological chemistry.

OSWALD SCHREINER and J. J. SKINNER: *The Effect of Guanidine on Plants under Different Conditions.*

Guanidine is harmful to plants. The effect of 50 parts per million was tested on wheat seedlings in solution cultures and in soils. The solution cultures consisted of nutrient solutions of varying composition in phosphate, nitrate and potash. The toxicity of the guanidine does not show until the fifth or sixth day, when spots appear on the leaves and soon the plant is completely affected and by the end of the second week the tops fall over. The effect of nitrates in the cultures is especially striking in that the harmful effect first shows itself in the cultures highest in nitrate and spreads gradually to those lower in nitrates and frequently does not appear at all in those cultures which contain phosphate and potash but no nitrate. In other words, we have here the interesting case of a harmful nitrogenous constituent, the harmful effect of which is accentuated by nitrates. Nitrogenous compounds other than nitrates, such as asparagine, creatinine or stable manure, when used in conjunction with guanidine, did not produce the harmful effect noticed with sodium nitrate.

WILLIAM SALANT and J. B. RIEGER: *Further Studies on the Demethylation of Caffein.*

Studies carried out on rabbits, guinea-pigs, dogs and cats show that demethylation in the carnivora takes place far more readily than in the herbivora, the amounts of caffein eliminated unchanged by the former being very small. The process of demethylation therefore varies quantitatively as well as qualitatively in the above animals.

C. B. BENNETT: *Note on the Distribution of Inosinic Acid.*

Inosinic acid was isolated and identified from the fresh muscular tissue of pigeons.

L. E. WARREN: *A Note on the Poisonous Properties of Parthenocissus quinquefolia.*

The death of a child after eating the berries of the Virginia creeper was recently noted by the public press. While the recorded instances of poisoning from this plant are very few, an examination of the literature showed that oxalic acid has been found in nearly all parts of the plant.

Its quantity does not appear to have been determined, but, pending further investigation, the plant should be regarded with suspicion.

I. G. McBETH and R. C. WRIGHT: *Certain Factors Limiting Nitrification.*

Two per cent. of glucose and two per cent. of starch disappeared from soil in less than seven days. Cellulose disappeared more slowly. The addition of glucose and starch caused a rapid disappearance of nitrate from eastern and western soils; with cellulose the reduction of nitrate was less rapid.

Two per cent. of fresh horse manure caused only a partial disappearance of soil nitrate. After seven days in eastern soil and twenty-one days in western soil nitrification became active, causing an increase in nitrate.

Nitrification took place rapidly in rotted manure; the addition of five per cent. of cellulose caused rapid denitrification.

Nitrification in the soil is inhibited by carbonates, chlorides and sulphates, the former having the strongest effect and the latter the least effect.

There are certain seasonal variations in the rate of nitrification in soil.

J. B. RIEGER: *Identification and Precise Estimation of Minute Amounts of Caffein in Physiological Products.*

M. O. STAFFORD: *Preliminary Study of Iron Peptonates.*

V. K. CHESNUT: *Estimation of Small Quantities of Pepsin.*

M. LOUISE FOSTER: *A Study of the Decomposition Products of Milk Caused by B. lactis erythrogenes.*

Sterile milk inoculated at room temperature with *B. lactis erythrogenes* gave after a few days a faintly red solution, which on longer standing became blood red with coagulation of the milk. During standing—from two to six months—the red liquid became viscous, then fluid again with the formation of a white granular precipitate. The liquid was alkaline and gave the biochemical tests which showed that the organism had attacked the protein molecule as well as the carbohydrate. From 5 to 8.6 per cent. of the total native protein remained unattacked while the remainder was identified as proteoses and monamino acids. The pigment was extracted with amyl alcohol and precipitated with acetone in clusters of red crystals. Further, colorless crystals with alkaloidal odor were obtained. An enzyme was isolated in the usual way. It was found to coagulate milk, giving

a supernatant liquid acid to litmus. This acidity was found to be due to the presence of acetic and formic acids. No lactic acid was found.

OLIVER E. CLOSSON: *Local Anesthetics: Some Comparative Physiological Reactions.*

W. H. SCHULTZ and ATHERTON SEIDELL: *The Elimination of Thymol. I. Feces.*

A. B. MACALLUM: *The Role of Surface Tension in the Distribution of Salts in Living Matter.* (Illustrated with lantern slides.)

J. F. BREAZEALE and J. A. LECLEERC: *The Influence of Reaction of Culture Medium on the Development of Roots of Wheat Seedlings.* (Illustrated.)

G. A. MENGE: *Some New Compounds of the Choline Type.*

CHARLES B. BENNETT: *Note on the Distribution of Inosinic Acid.*

OSCAR RIDDLE: *On the Chemistry of the White and Yellow Yolk of Ova.*

D. W. WILSON and P. B. HAWK: *On the Relation between Water Ingestion and the Ammonia, Phosphate, Chloride and Acid Concentration of the Urine.*

LAWRENCE T. FAIRHALL and P. B. HAWK: *The Fecal Amylase Output during Fasting and Water Drinking.*

D. W. WILSON, P. E. HOWE and P. B. HAWK: *The Distribution of Urinary Nitrogen as Influenced by the Ingestion of Moderate and Copious Quantities of Distilled Water at Meal Time.*

CHARLES O. APPLEMAN: *Metabolism in Dormancy of Tubers.*

A. D. EMMETT and CARL CHRISTOPHER: *Effect of the Quantity of Protein Ingested on the Nutrition of Animals. V. On the Chemical Composition of the Skeleton of Swine.*

The skeleton of pigs, selected from three lots—fed on low, medium and high protein planes—showed: (a) that the percentage of fat varied with the protein fed; (b) that the per cent. of protein was lowest in the low-fed lot and the same in the other two; (c) that the per cent. of ash and phosphorus seemed to be independent of the feed. With the tibia, femur and humerus bones, their weight, length, diameter, breaking strength and modulus of rupture seemed to suggest that the medium-fed pigs had the most compact and firm bones. The weight of the skeleton was greatest percentagely in the low-fed lot.

A. D. EMMETT and H. S. GRINDLEY: *The Relative Nutritive Value of the Cuts of Beef.*

Comparing the protein and fat content of the

edible meat of the eleven wholesale cuts of beef obtained from three steers—the flank, plate, rib, rump and loin were highest in fat, and the clod, round and shanks in protein. Fat made up from 68 to 92 per cent. of the total calorific value. The energy varied directly as the percentage of fat, ranging from 235.1 calories in the clod to 554.9 in the flank. Comparing the grams of meat required to supply 100 calories from the fat and protein, it takes about half as much of the fatter cuts. The most economic cuts from this standpoint are the chuck, plate, clod and shanks.

E. W. MORSE and L. W. FETZER: *The Present Knowledge in Regard to the Nature of Peach Yellow Disease.*

Summing up our present knowledge in regard to the disease of peach trees known as yellows, it seems natural to conclude that this is a constitutional disease which is inheritable; that is, the progeny have inherited a hypersusceptibility to the disease. The symptoms of the disease—premature ripening of the peach and the appearance of superficial red spots and streaks throughout the flesh of the same, and a yellowing of the leaves the following spring, etc.—seem to point to the hypothesis that the disease is a metabolic one, due to a disturbance of the equilibrium among the enzymes of the plant. Probably there is a hyper-production of the oxidases and a lesser production of the other enzymes, which are active during the life cycle of the plant.

A. R. ROSE: *The Influence of Phytin on Seedlings.*

Phytin has been found universally present in seeds and by some investigators considered to play a significant rôle in germination and early growth of plants and the growths of animals. Nagaoka, Aso and Yoshida in the Imperial Agriculture College in Tokyo have shown that the phosphorus of plants are less beneficial to plant growth than that from animal scraps and wastes, also that the soluble organic phosphorus gave poorer ultimate results as fertilizer material than leicthans and the various inorganic forms of ortho-phosphates except AlPO_4 and FePO_4 . In view of this, experiments were planned and executed to determine, if possible, what the influence of these phosphorus compounds may be upon the earliest growth of the plants. Lupin seedlings were germinated and afterwards allowed to grow in nutrient solutions, some of which contained a phytin compound, for periods of two or more weeks and the influence on the primary root noted. The results seemed to indicate that the several phytates behaved in the

same manner as the corresponding ortho-phosphates. There was no suggestion of any specific influence of the phytic anion upon the seedlings. The phytin solutions in which the seedlings had grown showed no increase in inorganic phosphorus nor inositol and there was therefore no evidence that the phytase of the seed acted upon the phytin in the surrounding liquid. The author contemplates further experiments along this line.

A. R. ROSE and J. T. CUSICK: *The Influence of Phosphorus Compounds on the Yield and Composition of Goat's Milk.*

A preliminary report of a metabolism experiment, the fifth of a series planned by Director Jordan. The former experiments conducted with cows gave interesting results with respect to the milk flow and composition. There was a consistent increase of fat and decrease of milk volume with the increase of phosphorus over a very low phosphorus ration, and *vice versa*. The other constituents of the milk were not appreciably affected. A recent paper by Fingerling gives results contrary to these conclusions, but he used goats and his rations were of different constituents in the high and low phosphorus periods. The data from this experiment tend to confirm the conclusions of the previous experiments at this station and are not at all in harmony with Fingerling's observations, but the results are not as consistent as were those when cows were used. There is a regular parallelism between the milk flow and the various constituents of the milk, except with respect to the fat. In two of the four periods the fat increased and the milk flow decreased with the increase of phosphorus in the rations; in the other two periods the reverse was true. Further investigations are now in progress at this station.

A. R. ROSE: *The Toxicity of Phytin.*

A series of experiments conducted on rabbits weighing approximately 2 kilograms gave in two cases unexpected results. Feeding five grams of the sodium salt of phytin was followed in one and one half hours by death. Analysis of the stomach and intestinal content yielded almost half of the soluble organic phosphorus administered. Death was therefore apparently due to 3.2 grams and 3.66 grams sodium phytate, or 1.7 grams per kilogram.

Methods used and an improved cage described.

H. M. ADLER: *Vicarious Fat Deposits in Rabbits Chronically Poisoned with Oil.*

A. A. EPSTEIN and S. BOOKMAN: *Studies in Glycolipid Formation in the Body.*

ALBERT A. EPSTEIN: *Contribution to the Study of Blood Serum and Serous Effusions.*

The composition of blood sera varies in disease. The changes which occur require careful analysis in close relation with the pathology of the disease investigated. The relation of disease to the production of changes in the chemical composition of the blood, and, also, the relation of alterations in the blood to the production of disease are subjects requiring special study. The effusions present distinct chemical differences, depending upon the site of their production, the nature of the underlying disease and the chemical composition of the blood.

ALBERT A. EPSTEIN: *Immuno-chemical Studies on Peptones.*

The different peptone fractions seem to be able to alter the different blood elements sufficiently to affect their immunological reactions. This power is not possessed by all the peptones equally, either qualitatively or quantitatively. If we regard the phenomenon of hemolysis by immune serum in the light of a biochemical process, depending upon properties possessed by certain constituents of the serum and the red blood cells, the albumoses and peptones show differences in their behavior toward the elements concerned in the production of hemolysis.

THEO. KUTTNER: *Some Findings in Two Cases of Bismuth Poisoning.*

The urine of patients to whom bismuth subnitrate and bismuth subcarbonate had been administered was found to contain bismuth. It is commonly supposed that the organism does not absorb these bismuth compounds.

W. A. WITHERS and B. J. RAY with the collaboration of R. S. CURTISS and G. A. ROBERTS: *Studies on Cotton-seed Meal Intoxication. I. As to Pyrophosphoric Acid.*

JAMES N. CURRIE: *Studies on the Flavor of the Green Mold Cheeses.*

A study of the volatile fatty acids of the green mold cheeses, Roquefort, Gorgonzola and Stilton, shows that the fat undergoes a marked hydrolysis during the ripening process. This change is doubtless accomplished by a lipolytic enzyme of *Penicillium roqueforti*, which, according to Thom, is concerned in the ripening of all of these cheeses. The characteristic peppery taste of the green mold cheeses may be, at least partially, ascribed to an accumulation of caproic, caprylic and capric acids, or their readily hydrolyzable ammonium salts.

H. P. BASSETT: *Transformation of the Fruit Acid by Animal Enzymes.*

WILLIAM H. WALKER: *Electrical Apparatus for Use with Benedict's Method for the Determination of Urea.*

MAX KAHN: *On the Absorption and Distribution of Aluminium from Aluminized Food.*

When biscuits baked with alum baking powder are fed in a mixed diet to dogs, aluminium passes in considerable amounts into the blood.

Such absorbed aluminium circulates freely and tends to accumulate to some extent in the various organs.

Aluminium is partially excreted by the liver in the bile and is also eliminated in the urine.

CHARLES H. SANFORD and JACOB ROSENBLUM: *On the Glycyltryptophan and Tryptophan Tests for Cancer of the Stomach.*

T. B. ALDRICH: *On Feeding Young Pups the Anterior Lobe of the Pituitary Gland. I.*

Seven pups, five females and two males, as soon as weaned were separated into two groups A (4), B (3), weighed and fed on bread and milk only for eight days. They were then reweighed and each pup in group A received daily in addition to his milk and bread diet 50-75 mg. of the fresh desiccated, defatted anterior lobe of the pituitary gland; each in the other group received an equal amount of desiccated, defatted ovary. The pups were weighed usually every fourth day and the weights recorded in tables and charts. The experiment extended over nearly four months. These records show that the controls increased in weight faster than the pituitary-fed pups. One pituitary-fed pup weighed the most; but the group curve shows the controls had much the advantage. These observations are not in accord with Professor Schafer's findings, who found that the anterior lobe stimulated the growth of young rats. Further experiments are necessary to decide whether the anterior lobe has a stimulating action or not on young animals.

I. K. PHELPS and C. S. HUDSON: *A New Crystal-line Product from Yeast.*

F. C. WEBER and H. W. HOUGHTON: *Notes on a Few Chemical Methods for the Detection of Deterioration in Flesh Foods.*

CHARLES B. LIPMAN: *The Toxic and Protective Effect of Salt as Related to Soil Bacteria.*

BURTON E. LIVINGSTON: *Incipient Drying in Plants.*

When water loss from the exposed membranes of leaves occurs at a rate higher than that at which

water of imbibition enters these membranes from within, then the surfaces must begin to dry. This phenomenon, which may be termed *incipient drying*, actually occurs in leaves which are subjected to relatively high transpiration. It acts as an automatic check upon transpiration. These considerations are important in the study of the water relations of plants; they also seem to bear upon the physics and chemistry of the formation of cuticle, etc.

M. MCCOOL: *The Toxic and Antagonistic Relations of Manganese.*

JOINT PROGRAM OF THE BIOLOGICAL SECTION OF THE
AMERICAN CHEMICAL SOCIETY AND THE AMERICAN
SOCIETY OF BIOLOGICAL CHEMISTS

THOMAS B. OSBORNE and L. B. MENDEL: *Maintenance and Growth.*

WILDER D. BANCROFT: *The Study of Environment.*

When studying the effect of environment on an organism, we must distinguish three distinct things: the direct effect of new external conditions involving no adaptation; the adaptation of the organism to the new conditions; and the possible inheritance of the adaptations. The botanists have not made these distinctions. They consider the change of curvature of tendrils with change of temperature as a case of non-adaptive response, whereas it has no more to do with adaptation than the shortening of a fishing-line when it is wetted.

The problem of the inheritance of acquired characters has been complicated unnecessarily by the arbitrary limitation that the character must be inherited for four or five generations after the organism has been brought back to the original surroundings. Since an organism which responds readily to a new environment will also revert readily when brought back, this definition has probably excluded most of the cases in which the inheritance of acquired characters could be shown. The biologists seem never to have realized that inheritance is primarily a hysteresis phenomenon and should be studied as such.

TREAT B. JOHNSON: *The Synthesis of Thiotyrosine.*

A knowledge of this new amino acid was especially desirable, in order to acquire a more definite conception of the true nature of sulphur combinations in proteins. The acid has been prepared by the application of a new, general method for the synthesis of alpha amino acids and its chemical properties are now being studied.

The most important characteristic of the acid, so far observed, is the fact that it does not give

Millon's test. On the other hand, it gives, on warming the concentrated sulphuric acid, a characteristic color reaction, as the Milton's test is characteristic for tyrosine. This study is one of a projected series on new sulphur combinations which has been planned for the Sheffield Laboratory.

ALFRED DACHNOWSKI: *The Relation of Vegetation to the Chemical Nature of Peat Soils.*

C. L. ALSEBERG and O. F. BLACK: *Phytochemical Studies on Hydrocyanic Acid.*

J. H. LONG: *The Definition of Normal Urine.*

Our notions as to what is a normal urine have undergone many changes in the years which have elapsed since the first attempts were made to establish standards.

The same individual, at one time on a high protein diet and again on a low protein diet will excrete urine which will be markedly different in many ways, and yet both will be normal.

Improved methods of examination have shown that hyaline casts are much more frequently present in the urine of healthy men than was suspected a few years ago, and it must be admitted that traces of albumin occur in the urine of men who, from all ordinary points of view, are perfectly well.

The statement as to what constitutes normal urine must take cognizance of these facts, and of the further fact that for each individual there seem to be agencies at work which modify the nitrogen distribution, the acidity and the natural sulfur in ways which we can not account for. In a certain sense each individual has his own standard of normality.

ANDREW HUNTER and MAURICE H. GIVENS: *The Nitrogen Excretion of the Monkey, with Special Reference to the Metabolism of Purines.*

A female monkey (*Cercopithecus calthrichus*), weighing 4.7 kilograms, was maintained for 40 days on a daily ration of 200 c.c. whole milk, 200 grams bananas and 20 grams peanuts. The urine was collected every 48 hours. For the first 16 days the average daily excretion of N was 1.83 grams, distributed as follows: urea, 1.59; NH_3 , 0.028; creatinine, 0.065; allantoin, 0.015; purines, 0.0027; undetermined, 0.13 gram N: or, urea 86.9; NH_3 , 1.5; creatinine, 3.5; allantoin, 0.82; purines, 0.15; undetermined 7.1 per cent. of the total N. Uric acid could not be detected.

During the remainder of the experiment attention was devoted particularly to the metabolism of endogenous and exogenous purines. On seven

normal two-day periods the excretion of allantoin N ranged from 27.0 to 31.8, that of purine N from 4.7 to 10.3 milligrams. On five periods, each interpolated between two normal ones, doses of 0.5, 0.5, 1.0 and 2.0 grams sodium nucleate were administered. Of the purine N thus fed 90, 56, 41, 24 and 29 per cent., respectively, of the theoretically possible was recovered in the form of allantoin and urinary purines. Of the amount so recovered 79 to 98 per cent. took the form of allantoin; after the second dose of 0.5 gram 2 per cent., and after 2.0 grams 9 per cent. appeared as uric acid. In normal periods allantoin accounted for 71-87 per cent., in nucleate periods 77-86 per cent. of the total purine-allantoin N. In respect of the ratio between allantoin and purine excretion the species examined resembles the lower mammals rather than man. On the other hand, we did not meet with the almost quantitative conversion of exogenous purines into allantoin, which has been reported for the dog.

H. S. REED and H. S. STAHL: *Oxidizing Enzymes in Certain Fungi Pathogenic for Plants.*

The oxidizing ability of the plant extract is often altered as a result of the invasion of parasitic fungi. The extracts of apples invaded by *Sphaeropsis malorum* show no oxidizing powers whatever. Apples attacked by *Glomerella rufo-maculans* show, on the contrary, a somewhat increased oxidizing ability. When grown in pure culture on synthetic media *Glomerella* develops oxidizing enzymes in certain media but not in others.

WALDEMAR KOCH: *Should the Term Protogon be Retained?*

Data were presented which indicated that the preparations referred to as protogon contain at least three substances: a phosphatid containing cholin, a cerebrosid containing sugar, a complex combination of a cholin-free phosphatid with a cerebrosid to which an ethereal sulphuric acid group is attached. The term protogon can not, therefore, be said to have any chemical significance. The details will be presented in a more extended publication.

WILLIAM J. GIES: *Modified Collodion Membranes for Studies of Diffusion.* (From the Laboratory of Biological Chemistry of Columbia University, at the College of Physicians and Surgeons, New York.)

Lipins and many substances which dissolve in ether, alcohol and similar solvents can be dissolved, in large proportions, in U. S. P. collodion solution.

Such mixed solutions, when treated in any of the usual ways for the production of collodion membranes, yield composite homogeneous products. Lecithin, cholesterol, lard, olive oil, rubber, alcohol-ether-soluble protein, organic pigments, ferric sulfocyanate and many other substances have been incorporated homogeneously in such modified collodion membranes, which show interesting differences in permeability.

MORRIS S. FINE: *A Method for Differentiating between Metabolic and Residual Food Nitrogen of the Feces.* (From the Sheffield Laboratory of Physiological Chemistry, Yale University, New Haven, Conn.)

As a rule the methods previously employed for this purpose have not taken into account the fact that the indigestible materials, *e. g.*, cellulose and hemicellulose such as are present in cereals, legumes, etc., show a marked tendency to increase the elimination of fecal material. The following procedure is believed to offer certain advantages over those hitherto proposed. From the fecal nitrogen accruing from a given diet is subtracted the corresponding value resulting from a *non-nitrogenous diet, yielding practically the same amount of feces.* Such a non-nitrogenous diet may be conveniently obtained by adding agar agar to non-nitrogenous food whose calorific equivalent does not differ materially from that of the diet under investigation. The result thus obtained represents the amount of nitrogen of the latter diet which has *actually escaped utilization.*

E. MONROE BAILEY: *Biochemical and Bacteriological Studies of the Banana.*

An earlier study¹ has been extended. Enzymes concerned in ripening processes have been investigated, and in addition bacteriological and chemical examinations of the fruit in various stages of maturation have been made. Amylase, sucrase, raffinase, protease, lipase and peroxidase were detected. Tests for maltase, dextrinase and lactase were doubtful or negative. The inner portions of the pulp of sound fruits appear to be sterile, but the regions of the inner coats of the peel may be sparsely inhabited by bacteria. As ripening progresses, starch disappears and the content of alcohol-soluble sugars and dextrins increases. Maltose could not be detected.

CHARLES L. PARSONS,
Secretary

(To be continued)

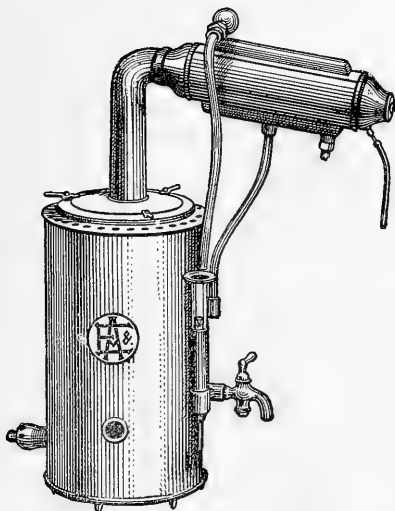
¹ *Journal Biological Chemistry*, I., pp. 4 and 5, 1906.

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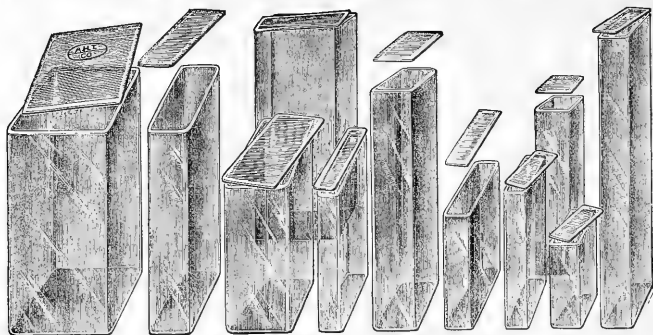
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THE PRIVILEGES AND RESPONSIBILITIES OF THE CHEMICAL ANALYST¹

IN his presidential address on "The Dignity of Analytical Work," delivered before the American Chemical Society in 1897, Dr. Charles B. Dudley directed attention to the claims which may be asserted in behalf of analytical chemistry as an important and dignified branch of chemical science, and the necessity for intelligent, careful work on the part of even the routine analyst. From a somewhat different standpoint, Dr. W. F. Hillebrand, of international reputation as an analyst, presented at the Philadelphia meeting of the Society, in 1904, a critical review entitled "Some Thoughts on the Present Conditions of Analytical Chemistry," which was based upon his experience as chairman of committees intrusted with the formulation of standard methods of analysis and the investigation of the causes for the remarkable variation in the results of different analysts examining a given sample of material. He sounded a definite and clear note of warning with respect to the prevalence of a lack of care and intelligence, and ascribed the conditions, in part at least, to faulty training in our educational institutions. Within the past month there has appeared an interesting brochure from the pen of Dr. Wilhelm Böttger, professor at the University of Leipzig, entitled "Der Stand und Wege der Analytischen Chemie," in which he criticizes the too empirical nature of much of the analytical

¹ Read at a joint session of the American Chemical Society and Section C of the American Association for the Advancement of Science at Washington, December 27, 1911.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

practise of the day and makes valuable suggestions respecting the way out of these conditions.

Dr. Dudley's plea was authoritative and convincing, and attracted much interest when it was made public. Dr. Hillebrand spoke from a fullness of experience and with an earnestness which made his criticism strike home. Dr. Böttger writes from the viewpoint of one who is at home in the analytical field and has also thoroughly familiarized himself with the advances of chemical science in other lines which are closely related to the work of the analyst. Is there, then, an excuse for a fresh homily on the status of analytical chemistry? May I say frankly that, had the pamphlet from Dr. Böttger reached me before the title of this address had been announced and its general outline prepared, I should have been inclined to answer this query in the negative, and may I confess that, since Dr. Böttger can write with greater authority than I on certain phases of the present situation, I shall quote freely from him.

But, on the other hand, it is probable that not many of you have recently read the addresses referred to above, a thing to be strongly recommended at your next opportunity, and it is certainly true that too many of the chemical analysts (not alone the "analytical chemists" in a professional sense) are not putting out a grade of work which is commendable to them. It is not unreasonable, then, that we should take time to survey the field; nor is it true that such a survey will show no signs of improvement from which we may take comfort and courage.

When we consider the relation of analytical chemistry to the other branches of our science, we still face such questions as these: Why is it that analytical chemistry lags behind other branches of chemistry in its scientific development? Why is it that

our journals are so often filled with "new" processes of alleged reliability and usefulness, which never acquire general recognition and which are frequently condemned as worthless by those who attempt to apply or repeat them? Why is it that reports of commission after commission on "standard" methods are published, only to sink into oblivion without awakening any interest or attaining any useful purpose? Why is it that the chemical analysts, as a class, lack the respect which should be commanded by those who are following a profession and practising an art which, in its best estate, calls for a very high degree of intelligence, as well as manual skill? Why is it that chemical analyses have come to be made at prices worse than those of the bargain counter? These are, it appears, all pertinent questions to-day.

It has been frequently pointed out that analytical chemistry has so long been regarded as the servant of the chemist—referred to by Ostwald as the "hand-maiden" of chemistry—that far too much attention has been directed to obtaining large returns for small wages. We have nearly forgotten that this "hand-maiden" herself has a natural comeliness, and have ignored the fact that even a little more encouragement to her to improve her methods and accomplish her tasks more thoroughly would easily fit her to sit at the family table—a privilege, formerly hers, of which she has long been deprived. It is easy to see, as Dr. Böttger points out anew, how, after the days of Liebig, the relegation of analytical chemistry to a subordinate position came about amid the interest attaching, first, to rapid developments in organic chemistry, and later to those in physical chemistry, and especially through its connection with the phenomenal growth of the industries, which demanded "results" and too often have allowed what appeared to

be "good enough" for a temporary purpose to become a permanent standard of attainment. These latter conditions must, however, always be reckoned with, and it is not my purpose to spend time in deploring them, or in regretting the conditions of the past, but to ask what encouragement may be offered to the analyst of to-day and what the outlook is for the future.

My chief criticism of the situation in the recent past would be this: That the chemical analysts, as a class, have failed to take advantage of their opportunities, and that those intrusted with their training are considerably responsible for this situation. Specifically, I mean that too many practising analysts allow themselves to remain in ignorance of the aids to accurate, intelligent work which that branch of chemistry known as physical chemistry, in a broad sense, has contributed, and that, while our students are usually made familiar at some time with much of this material, it is not coordinated with their training as analysts. We train too much for manipulative skill and analytical facility and do not sufficiently educate toward that critical intelligence which enables a man to test his own work, to view it from the outside, as it were, and will not allow him to regard it as satisfactory until he has not only assured himself with respect to such matters as the purity of his reagents or the stability of his glassware, but has also studied the effect of a variation of individual factors and of the chemical conditions, so far as his time will permit. Obviously, a practising analyst can rarely afford the time to make his methods of analysis the subject of exhaustive investigations, but something far less than this, yet considerably more than is too often done, would have prevented many deplorable happenings, including the publication of many unreliable analytical procedures to the be-

wilderment of the entire chemical fraternity.

That the analyst who is ambitious to make the most of his privileges to-day is in a position to obtain a larger measure of aid and comfort than formerly is indicated by an instance cited by Dr. Böttger. He contrasts the work of Professor Clemens Winkler upon the atomic weight of nickel with the later work of Professor J. W. Richards, which showed the figure obtained by Winkler to be in error by 0.3 per cent. Winkler was highly skilled in the technique required for the work which he undertook, and possessed special mental aptitude for the task, as Richards himself has testified. It appears, then, reasonable to conclude that Richards, although similarly equipped, succeeded in attaining greater accuracy than Winkler rather because of his greater ability to recognize those factors which would lead to error than because of greater ability to overcome the difficulties after they had been recognized. Richards had at his command a qualitative and, in some cases, a quantitative knowledge of phenomena, unrecognized until recently, which permitted not only the detection of new sources of inaccuracy, but often enabled him to estimate the extent of the errors involved. He made the knowledge of the day serve his keen intellect to its utmost. He took advantage of his privileges.

But perhaps some of you will say, "This is atomic weight work, not analytical chemistry. Those men are ripe scholars and investigators who can command a knowledge of the advances of their science. All this has little to do with me, a busy analyst, or an unripe scholar." That, however, is just where the issue really lies, and it is because so many have thought and still think that a great deal of the accumulated chemical knowledge in the field of general or physical chemistry is "beyond them"

and is something reserved for the use of those with chemical leisure on their hands, that our progress toward better things is so slow. It is also the reason why a great deal of time is wasted on procedures which are almost without value as soon as any one of the particular conditions (often very far from practical conditions) under which they were tested, is altered. It is not at all a difficult matter to obtain an understanding of at least the meaning, for example, of chemical equilibrium and the laws which apparently underlie equilibrium phenomena; yet there are instances of the publication of processes recommending procedures in defiance of these principles, and a great deal of time is wasted in private because of ignorance of them. An interesting and fruitful application of these principles is to be found in connection with the processes of neutralization and hydrolysis, and in selection of suitable indicators for use with acids and bases of varying strength. Modern research has changed this from a haphazard procedure to one of comparative exactness. The principles are not difficult to follow and, if once mastered, can not fail to render any subsequent work in this field more intelligent and, therefore, more pleasurable.

The phenomena of adsorption, with their attendant annoyances to the analyst, have been widely studied. The results are perhaps less positively helpful than in the case of the indicators, but the material is nevertheless well worth attention and study. Colloids—which probably play an often unsuspected part in our analyses for good or ill—must not be overlooked by the well-informed chemist who would best economize his time and energies, and the simple matter of the best way to wash a filter and its contents, long ago pointed out by Ostwald, are not as familiar as they should be. The spectroscopy and micro-

scope are more useful than formerly, a system of micro-analysis, both qualitative and quantitative, having been developed with the latter instrument; the ultramicroscope may well open up new lines of study with respect to the formation of precipitates, the existence of colloids or the conditions controlling electrolytic deposition; wash-waters may now sometimes be advantageously tested through their electrical conductivity; the refractometer, the nephelometer, the colorimeter, the centrifuge, are all finding extended usefulness, and it is incumbent upon the analyst to understand these instruments, and their underlying principles thoroughly if he is to fully avail himself of their aid.

It is probable that analytical chemistry has been as directly aided by the increased accuracy of solubility determinations as in any other way; and these have largely been made practicable by the development of the physico-chemical methods of measurement. These determinations have made it possible to judge of the greatest attainable accuracy of a precipitation method, and have also made practicable the use of a correction factor in the case of unavoidable losses. The analyst should no longer content himself with the mere thought that such losses are inevitable until he has definite assurance that data sufficient to permit of a reasonably accurate estimation of these losses are not to be found. The values obtained for the solubilities of the various sulphides, which are much more accurate than those formerly available, have alone done a great deal to enable the working out of a more reliable scheme of qualitative detection of the elements, one which is based on scientific deductions, confirmed by careful experimentation, as, for example, in the separation of the sulphides of arsenic, antimony and tin by hydrochloric acid, the separation of zinc from the metals of the

copper group, the complete precipitation of lead and cadmium as sulphides.

It is so much a matter of common knowledge that the chemical changes upon which analytical procedures rest are far better understood, and therefore controlled, because of the fruitful hypothesis of Arrhenius, that no extended statement of this seems necessary in this connection. It may, however, be wise to point out that there is a certain tendency to assume that this theory and its applications constitute "physical chemistry" and that there is reason for complacency when one has acquired a fair understanding of these points. While the foregoing statements are far from complete with respect to those points at which our modern chemistry and physics touch analytical chemistry, it must be evident that the possibilities for assistance are far wider and, indeed, more important than a mere ionic interpretation of chemical changes. For it must be admitted that our knowledge of ionic changes, even in a qualitative sense, is still inexact with reference to many reactions familiar to the analyst, and that the most useful data are those of a quantitative character, to obtain which we must command a knowledge of the wider field of physical chemistry in a broad sense.

Modern investigation has then, especially in the border land between physics and chemistry, given us new tools for our trade as chemical analysts. But it has done still more for us by showing us what it means to use them, and it is here that, as analysts, we should learn our lesson. It is, I think, fair to say that the one fundamental reason why much of the published work of individuals or commissions fails of effectiveness and permanence and, in part, the reason for the lack of respect in which the chemical analyst and his work are held, is the lack of appreciation on the part of

authors of the one-sidedness of the published results, and of the procedures adopted as adequate or as the best obtainable. The pages of our journals are, unfortunately, too largely occupied by descriptions of processes, which are supported by data obtained under but one set of conditions, and applied at most to one or two sorts of materials. These conditions are empirically established and are, in many cases, not such as could be controlled under the necessary routine of analysis of materials of more complex structure. The tests, upon which efficiency is claimed, have often been made with pure materials, and in solutions, the contents of which could be easily adjusted and determined, contrasting in this respect with customary analytical conditions. Many authors of analytical procedures lose sight of the important fact that the success of these procedures, in their own hands, has usually been attained only at the cost of considerable practise and as the result of the observance of a series of, often, apparently minor modifications, which they more or less unconsciously ignore when they describe the process for publication. It is exactly this really inexcusable ignoring of these conditions, on the one hand, and the even more frequent failure to study their influence systematically, on the other hand, which has condemned much of the published material. It is true that the intelligent author is between two fires—on the one hand his desire to help his colleagues, on the other hand, the board of editors who, in these days of many papers, must insist upon reasonable brevity. As one who has seen many manuscripts in this field, may I suggest, especially to the younger authors, that I am sure that, while the editors must insist on the omission, for example, of statements to the effect that it is inadvisable to remove a stirring rod

from a quantitative solution without washing it, and, while they must advise the elimination of tabulated statements of the failures encountered on the road to success, and must, in general, curb a rather natural desire to send a four-page reprint containing two-pages worth of work to one's friends, they will welcome an increased exactness of statement of the controlling conditions of analyses, especially when it appears that these factors have been intelligently studied.

It is too obvious to really need mention, that not all of the published work is faulty, and it is notably true that some of the more recent work is of exceptionally high character and sets an excellent standard toward which analysts in general should strive. Reference will be made to only two well-known publications—those of Noyes, Bray and their associates on the development of a scheme of qualitative analysis on a scientific and exact basis, and the work of Allen, Johnston and Adams on the determination of sulphur as barium sulphate. In both these there has been a systematic study of sources of error and, where apparently unavoidable errors appear, the possibility of correction for them has been carefully investigated as well as the determination of the special conditions under which these errors could be reduced to a minimum. Dr. Bray has stated to me (and this view is confirmed by Dr. Böttger) that possibly the greatest service of physical chemistry is the impetus which the precise methods which have been worked out have given to the more critical study of the sources of error and to their prevention or correction. This, in their opinion, is a greater service than any other single attainment in itself.

It may be admitted that few employed as analysts can hope to obtain so complete an insight into other fields as is possessed

by Noyes, Bray, Böttger or Johnston, and their immediate coworkers. But it is not unreasonable to point out that a much less thorough knowledge would be of enormous assistance and would lead to the prevention of another fault in the point of view of most analysts; namely, the overlooking of the element of compensation of errors in their work. Few things would do more to bring up the character of analytical work than a better appreciation of the fallacies involved in "check analyses" or the false sense of confidence in an approximate summation to one hundred per cent. Just here, I believe, our teachers are often at fault. Every student tends to glorify his "check analyses," too often even to the destruction of his professional integrity. Even when there is no question of honesty involved, there is a blind faith in their infallibility, and this is reflected in much of the published work. The idea that two analyses carried out with practically identical weights of sample and equal quantities of reagents may "agree," but be perfectly worthless because of inherent errors, never really seems to penetrate the mind of many men. The fact that so simple a thing as variation in the quantities taken for analysis is a wise precaution in testing a process is also unperceived. I do not mean to say that most, or possibly all, teachers do not point out these matters, but I do mean to say that many students never get a clear perception of them, and still less of the idea that dependence upon compensation of errors in an analytical procedure is quite insecure unless the factors governing the occurrence of these errors are approximately known. I feel sure that these defects in our teaching would be lessened if we were, in general, to pay less attention to teaching a variety of methods, as such, and more to the careful investigation of a

few, on a scale commensurate with even the limited knowledge which a junior or senior really possesses. This should be done with the purpose of enabling him to criticize his own work, to study it for possible errors, their causes, and, so far as practicable, their amounts. He may then be encouraged to criticize the published work of others, for which, by the way, no end of useful material is at hand. In this connection, it may not be out of place to recommend to chemical analysts, teachers and practitioners an annual perusal of Dr. Hillebrand's address referred to above, in which he deals with the shortcomings of analysts with respect to reagents and manipulative methods, which it has not seemed necessary to attempt to touch upon here.

Finally, just a word regarding the status of the analytical chemist, using this term to denote one with whom analytical chemistry is essentially a vocation. There is, I think, no doubt that this is distinctly unsatisfactory. In the minds of the general public, to be sure, a chemist is essentially an analyst but, in the minds of employers, an analyst is too often an inferior grade of chemist who can be readily displaced by a reasonably intelligent boy, and whom boy's wages should satisfy. Our young men who have been chemically educated almost universally begin their professional careers in the technical field in our analytical laboratory. While we wisely admonish them to fulfil the task at hand in such a way as to earn more than they receive, to more than "make good," in the phrase of the day, we also urge them not to be content with such positions as will permanently restrict them to analytical service. This, too, under existing conditions, is no doubt wise. But it would seem that the time has come when employers should recognize that work entrusted to

boys who, while possibly capable of carrying out routine operations, have no ability to deal with any of the inevitable complications arising from exceptional conditions, or work entrusted even to men who are underpaid and without the encouragement of future adequate recognition, is likely to lack the requisite quality for the attainment of the best possible results. It may not be practicable to create permanently attractive positions for a large number of strong men, but there should be more of these men in the works laboratory than are now found there. Moreover, while a works laboratory is confessedly not a savory neighbor, the chemists should courageously demand that they should not be relegated to some ill-lighted, half-ventilated and dirty corner, as is too often done. This does not mean that quartered-oak desks, glass shelves or expensive trimmings should be asked for, but merely such quarters as will permit self-respecting men, who take pride in their work, to operate under conditions which permit them to render their best service. Some may say that this is an easy suggestion to make on the part of one not immediately associated with the stress of industrial conditions, but one which it is difficult to carry out. This is frankly admitted, but the belief persists that the analytical chemists owe it to themselves to make an effort to secure for themselves and their work a larger measure of recognition such as this suggestion would involve.

If we consider the current prices for chemical analyses, one is prone to think that in one field, at least, competition has had full play. It were, of course, rank heresy in this good city to suggest restraint, and yet it seems full time that something should be done, lest the day might come when the chemist would have to pay the manufacturer for the privilege of ma-

king analyses for him. How can an analytical chemist hope to maintain his professional standing when his charges for individual analyses—even when done in quantity—are such that, unless he is to count his own time as without value (and sometimes even under such an assumption), he can not possibly do reliable work without an actual financial loss? I do not wish to draw any unpleasant or unfair inferences as to which horn of such a dilemma the commercial analytical chemists choose; for the most of them are, no doubt, trying to make the best of a difficult situation. Unfortunately, I have no specific remedy to propose, but it is all too evident that these conditions tend to belittle this branch of our science, to result in a large output of inferior work, and to create a distrust which spreads unduly. It behooves us all to at least do what we can to bring home to those who are to place dependence upon work done at these ruinous prices that, in many instances, they are getting just about what they pay for and no more, and that the service is not such as they owe it to themselves to make possible by more adequate remuneration.

Whether we consider present analytical practise from the view of the scientist or as a vocation, we find much that calls for improvement. What the present situation imperatively demands, then, is a courageous and frank admission that the quality of much of the analytical work, practised or published, is inferior to what might reasonably be attained because much of it is one-sided and ill-considered from a scientific standpoint. Let there be a realization that, while no amount of theorizing can take the place of skilful and accurate work, or of a certain amount of empirical experimentation, the analysts should cease pulling on their own boot-straps and avail

themselves more generally of the aids from other portions of our science to help to lift themselves and their art to the worthy position to which both are entitled. Let the chemical analysts realize that they must take greater pride in their work for its own sake, let them demand a recognition of the dignity claimed for it by Dr. Dudley, and let them give to it the best that is in them, in both activity of mind and skill of hand. This is a duty which is owed to our national reputation, to chemical science, pure and applied, and to our own welfare.

H. P. TALBOT

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

*THE CROCKER LAND EXPEDITION UNDER
THE AUSPICES OF THE AMERICAN
MUSEUM OF NATURAL HISTORY
AND THE AMERICAN GEO-
GRAPHICAL SOCIETY*

THE existence or non-existence of land northwest of Grant Land and the configuration of the polar continental shelf of North America seem to be two of the greatest of the geographical problems still unsolved. There is, in addition, much important geological, geographical, zoological and other scientific work to be done in certain parts of the Arctic regions. Two thoroughly qualified young men have volunteered their services as leaders of an expedition to attack the problems and do the work. Under this combination of circumstances and with the proviso that sufficient funds be provided from outside sources, the American Museum of Natural History and the American Geographical Society have made liberal appropriations in support of the enterprise, and the former institution has taken over its organization and management, feeling that it is well worthy of the backing of the scientific institutions of the country.

The leaders of the expedition are to be George Borup (A.B., Yale, 1907), assistant curator of geology in the American Museum

of Natural History, and Donald B. MacMillan (A.B., 1898; A.M. (Hon.), 1910, Bowdoin). They have become well known to the public, scientific as well as general, through their work under Admiral Peary on his last polar expedition, through Mr. Borup's book, "A Tenderfoot with Peary," and his lectures and through Mr. MacMillan's extensive lecturing throughout the country. They have received Peary's unqualified indorsement for the work in hand. Mr. Borup has been devoting his whole attention during the past two and a half years to studies in the field and at Yale to fit himself thoroughly for scientific geological and geographical exploration. He is a fellow of the Royal Geographical Society (of London) and a member of the New York Academy of Sciences. Mr. MacMillan, since his return from the Peary expedition, has been studying ethnology and practical astronomy at Harvard. In the summer of 1910, he was a member of the Cabot party which was the first to cross central Labrador from the sea to George River, and he spent the summer of 1911 cruising along the coast of Labrador in an eighteen-foot open canoe, studying the Eskimo from Hopedale to Killinek (60° N. Lat.). Mr. MacMillan is a member of the American Geographical Society and the Appalachian Mountain Club.

The object and work of the expedition may, perhaps, be best stated in Mr. Borup's own words:

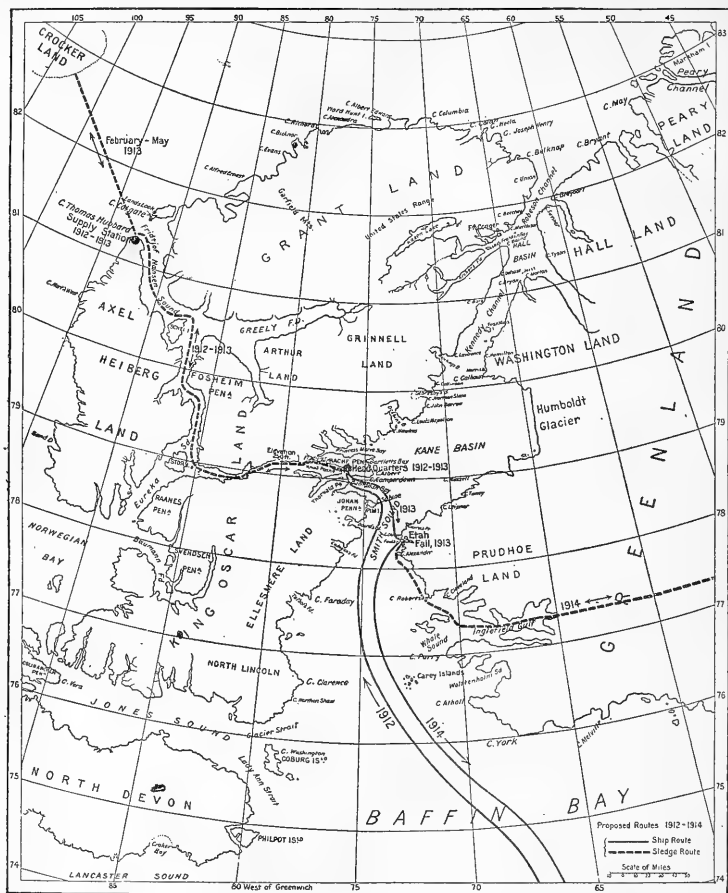
Belief in the existence of a land mass northwest of Grant Land rests on deductions made by Harris and observations made by Peary. Admiral Peary in his book "Nearest the Pole" reports having seen the "faint white summits of a distant land" on 24 June, 1906, from 2,000 feet above sea level on Cape Colgate and again six days later from 1,600 feet altitude on Cape Thomas Hubbard. It was calculated that this land lay about 130 miles out in the polar sea and in 100° W. Long. and 83° N. Lat. To it Peary gave the name Crocker Land. Dr. R. A. Harris in his monograph on "Arctic Tides" (1911) gave his reasons for concluding from a plotting of the cotidal lines of the Arctic regions that a great tract of land, an archipelago or an area of shallow water, trapezoidal in outline and half a million square

(statute) miles in area lies north of eastern Siberia and northern America. He places one corner of his trapezoid northwest of Grant Land and identifies Peary's Crocker Land with it.

The new expedition proposes to make soundings along the line from Cape Thomas Hubbard to Crocker Land, to determine the situation of the continental shelf, to collect samples of the ocean floor and to take temperature observations of the water at various depths and by attaching a small net to the sounding wire, to obtain specimens of oceanic life. These soundings, taken in connection with those made by Admiral Peary between Cape Columbia and the Pole, and by Nansen on the drift of the *Fram* starting in latitude 78° 50' north, longitude 133° 37' east, north of Siberia, to 85° 57' and thence down the west coast of Spitzbergen, will give a fair idea of the configuration of the floor of the Arctic seas. Tidal observations will be made at Cape Thomas Hubbard and at such points on Crocker Land as are found to be practicable. Such observations are highly desirable as supplementary to the records already secured on the north coast of Greenland and Grant Land by Marvin, MacMillan and Borup in connection with the last Peary expedition. On Crocker Land itself it is proposed to make a topographic map of the coast line and of parts of the interior, and if feasible to map geologically such parts as are visited; but in any case, to note the stage of physiographic development, the formations represented, and to collect specimens of rocks, of fossils and of living plants and animals.

In order to increase the scientific value of this expedition and in order that it may yield definite scientific results in the event of failure to reach Crocker Land, it is proposed to explore and to make detailed scientific observations in Ellesmere Land, Grant Land and Greenland. A part of the north coast of Grant Land will be studied and during one summer or late spring it is proposed to make a trip from Whale Sound (Inglefield Gulf) directly east into the interior of Greenland. By taking this course, the height of the ice cap may be ascertained and observations made of this great ice sheet supplementary to those of Peary, Nansen and Nordenskiöld. Nansen's studies were slightly south of the Arctic circle where the land is not very wide. The two journeys of Peary from Whale Sound to Independence Bay were made relatively near the shore.

After consultation with various scientists as to what classes of work will yield the greatest return, it is proposed to make the following studies:



THE PROPOSED ROUTE OF THE CROCKER LAND EXPEDITION

(a) *Geography*.—The coast lines and interiors will be mapped by plane table, barometer, continuous tracing of valleys, etc.

(b) *General Geology*.—Observations on the geology of Ellesmere Land and Grant Land have been made by the Norwegians under Sverdrup and the English Expedition of 1875-6, but their work was

necessarily of such a preliminary character that very little concerning the age of the formations and the relative abundance and character of the igneous and sedimentary rocks was learned; and nothing concerning the physiographic conditions of these areas was determined. It is proposed therefore to make detailed areal studies of the geology

of these regions and to make rather complete collections wherever possible.

The scattered paleontological data in this region which now are of small value could be made of much greater significance by studies such as are proposed. Along physiographic lines practically nothing has been done and the broad question of cycles of erosion involving possible climatic changes furnishes a fascinating subject of study of far-reaching scientific importance. The structure of these areas as indicating the character and extent of the larger earth movements in the Arctic regions and the original structures of the larger land masses could be determined by such studies as we propose.

(c) *Glaciation*.—It is proposed to make a thorough study of glaciers, glacial motion and the process of erosion by glacial ice caps. The geological importance of ice in molding land forms has been studied in existing glaciers, but the process of land molding under a continuous moving ice cap is not understood and there is here an opportunity for making observations which are significant not only for the present geological era, but also for Permian and Cambrian eras. It is proposed to make a special study of the so-called "glacial fringe" on the shores of the polar sea which to a limited extent resembles the great Ross Barrier of the Antarctic. The land and sea ice meet on the north coast of Grant Land, about five miles off shore. The land ice or "glacial fringe" is not a true glacier, but a combination of glaciers from the land and the heavy ice of the fiords which merge into a sort of piedmont glacier. There are no crevices in the ice surface aside from "tidal cracks," but it is thrown into great swells or waves 30-40 feet high and from a few hundred yards to a mile in length, which run generally normal to the shore. From this fringe come the floe-bergs and many heavy ice floes of the polar seas. This "glacial fringe" forms a unique and interesting feature of glaciation, and a study of its character and effects is of the highest importance to glacialists. In this connection attention has been called to an interesting feature by Colonel Feilden, the naturalist to the English Arctic Expedition of 1875-6, who says: "There is a lot of drift wood knocking about. I got it from off the floes up to 1,000 feet elevation—the interesting question is whether it comes from the Mackenzie or from Siberia? I do hope they will make a most careful investigation of the raised beaches and their contents. Also the birthplace of those mysterious boulders which are strewn along the

shores and to high altitudes in Grand Land and North Greenland."

(d) *Meteorology*.—It is proposed to make continuous barometric and thermometric observations at all points visited and an endeavor will be made by use of box kites to secure data as to temperature and direction of the upper air currents. No work of this sort has been previously done in such high latitudes, and it is probable that interesting data regarding atmospheric circulation will be obtained.

(e) *Tidal Observations*.—As stated before, observations will be made at Cape Thomas Hubbard and at points on Crocker Land. Mr. O. H. Tittman, superintendent of the Coast and Geodetic Survey, in a letter says, "Tidal observations, if carefully made for even a few days at a place, will be appreciated at this office. The localities in which such information appears to be most desired are: Axel Heiberg Island, Greeley Fiord, northwest coast of Grant Land, any undiscovered land to the northwest of Grant Land, the north coast of Greenland at points between Cape Bryant and Cape Morris Jesup. Any soundings which may be taken to the north of known land will be of interest to this office and to geographers generally."

(f) *Ichthyology*.—Hitherto practically no fish have been caught in these waters by any of the previous expeditions except a variety of salmon trout found in fresh water lakes. The fish do not seem to rise to bait.

In Smith Sound and Kane Basin there are great numbers of fish, however, as proved by the innumerable seals found there. Their chief diet is fish. Numerous good-size fish bones were also found in the stomachs of narwhals killed by Peary's last expedition.

By taking nets, trawls, etc., along, fish new to science may be caught and in all events we can prove what kind of fish inhabit these waters.

(g) *Ethnology*.—The Eskimos will be studied, their mode of life, traditions and language. It is planned to take a phonograph and make records of their language, songs, etc.

It is also intended to use the new adaptation of color photography to moving pictures in depicting various phases of animal life. This has never been done in the Arctic. Many very interesting and valuable moving pictures of the life in the north remain to be taken, such as camp life, building igloos, driving dogs, hunting and especially a good walrus fight.

(h) *Ornithology*.—Complete collections of eggs and birds will be made. Photographs of the nest-

ing places and the young will be taken; moving pictures showing the marvellous abundance of bird life, etc., will be secured.

(i) *Mammalogy*.—Specimens of all kinds of animal life will be secured, including bear, foxes, deer, mush oxen, hare, lemmings, walrus, and several kinds of seals. Measurements of narwhals and white seals will be made to supplement those taken by Mr. Roy C. Andrews in the Pacific.

The plan of campaign as laid down by Messrs. Borup and MacMillan is as follows:

Leave Sydney, N. S., by special steamer about 20 July, 1912. Collect whale and walrus meat and dogs on the way northward. Land on the south side of Bache Peninsula (Flagler Bay), Lat. $79^{\circ} 10' N.$, and establish winter quarters. Send the ship home. About the middle of September, begin sledging supplies to Cape Thomas Hubbard, and carry the work on throughout the winter during the moonlight periods. Leave Cape Thomas Hubbard with the return of dawn in February, 1913, and push across the ice to Crocker Land. Leave Crocker Land about 1 May, and return to Cape Thomas Hubbard. Send a messenger to North Star Bay with news of the expedition, to be forwarded by Danish steamer to civilization. Carry on scientific work in Grant Land and along return route to winter quarters on Flagler Bay, arriving there in July, 1913. During the summer, transfer supplies and collections to Etah. In the spring and summer of 1914, make an expedition from Whale Sound (Ingfield Gulf) directly eastward to the summit of the ice-cap of Greenland, at the widest part of that island. Return to New York in the autumn of 1914 by special ship.

The following are some of the principal items of the outfit to be provided: three years' provisions for four or five white men, their helpers and their dogs, much of which, particularly the pemmican, has to be specially prepared and packed; clothing; instruments for all kinds of observations and records; photographic cameras, including those for moving pictures; a power boat for use in Flagler Bay and in crossing to Etah with supplies and collections after the return from

Crocker Land; salary of physician and wages of cook and helpers; a steamship to take the party to Flagler Bay in 1912 and another to go up for it in 1914.

A physician and a zoologist are needed to accompany the party throughout the whole expedition.

It is estimated that not less than fifty thousand dollars (\$50,000) must be provided for the absolute needs of the expedition, in order to enable it to accomplish the valuable results that have been outlined above, in spite of the fact that Messrs. Borup and MacMillan generously serve the expedition without salary during the period of its absence from New York. Subscriptions to the fund are invited. Checks should be made payable to and all correspondence should be addressed to the American Museum of Natural History.

In addition to the support of the institutions already named, subscriptions have already been made or promised by Yale University, Bowdoin College, New York Academy of Sciences, Groton School, Theodore Roosevelt, R. E. Peary, Thomas H. Hubbard, Zenas Crane, Mrs. C. B. Alexander, John E. Thayer and others. There remains to be raised about thirty thousand dollars, and the museum has opened an account, known as the "Crocker Land Expedition Fund," for the purpose of receiving and caring for all subscriptions made to the expedition. Checks to further its purposes should be drawn payable to the American Museum of Natural History and forwarded to that institution. A list of subscribers will be published later and will be included in the final report.

The honorary committee on the Crocker Land Expedition consists of Henry Fairfield Osborn, president, American Museum of Natural History; Chandler Robbins, chairman of the council, American Geographical Society; Thomas H. Hubbard, president, Peary Arctic Club.

The committee in charge comprises E. O. Hovey, American Museum of Natural History; H. L. Bridgman, Peary Arctic Club.

All correspondence regarding the expedition should be addressed to Dr. Hovey.

GEORGE JARVIS BRUSH

GEORGE JARVIS BRUSH, LL.D., professor of mineralogy, emeritus in Yale University, died at his home in New Haven on February sixth in his eighty-first year. He was the last survivor of the first class to graduate from the Scientific School and the last member of a small group of distinguished men, who in the early days of the school devoted their lives to its service. With him passes a scientist who did much for the development of the science of mineralogy in this country and one who did even more for the general cause of scientific study and research.

He was born in the city of Brooklyn, December 15, 1831. An illness when a boy forced him to spend a year in the country and from this arose an interest in agricultural problems which later led him to Yale to take the newly established course in agricultural chemistry taught at that time by Professor J. P. Norton. In this way he became deeply interested successively in the subjects of chemistry, metallurgy and mineralogy. He entered Yale in 1848, leaving in 1850 to become an assistant in chemistry to Professor Benjamin Silliman, Jr., at Louisville. He received, however, in 1852 the degree of Bachelor of Philosophy with his class at Yale. In the same year he became an assistant in chemistry at the University of Virginia. It was here that he did his first important work in mineralogy in collaboration with Professor J. Lawrence Smith. Together they published a series of articles entitled "Reexamination of American Minerals," in which many new analyses were given and many points clarified which had been obscure in the early descriptions of American minerals. In 1853 Brush went abroad and spent two years of study in the laboratories at Munich and Freiberg. He returned to New Haven in 1856 as professor of metallurgy, which title he retained until 1864, when it was changed to professor of metallurgy and mineralogy. In 1871 the title was again changed to professor of mineralogy and this was retained until his death, the word *emeritus* being added in 1898 when he retired from active duties. He was deeply in-

terested in the development of the new scientific school in which he taught and was largely instrumental in its incorporation as the Sheffield Scientific School in 1861. He became the first director of the institution in 1872 and retained that office until his resignation in 1898. The earlier years of this period were critical ones, not only for the Sheffield Scientific School, but for the general cause of scientific education in this country. It is to be remembered that the public sentiment toward science was very different then from what it is to-day. At that time men like Professor Brush were especially needed who, with courage and far-sighted ideals, could strive against and gradually overcome the general distrust and disfavor with which scientific education was considered. In the scientific school he gathered a faculty of notable men about him and through his enthusiasm and faith inspired them with a devotion and unity of purpose which has had few parallels.

Much of his power lay in his ability to successfully organize and direct. That he had a keen business sense is shown in the material advancement of the school under his leadership and also in the fact that his services were always in demand by various public business organizations as a director and officer.

In his younger days, before his administrative duties became too heavy, Brush did considerable investigation in mineralogy, as the appended bibliography will show. He was, furthermore, always an inspiration to other workers in that field. It was through his enthusiasm and interest that the remarkable mineral locality at Branchville, Connecticut, was thoroughly explored. The results of these investigations were published in a series of papers by him in collaboration with Professor E. S. Dana. The work also involved a series of chemical analyses by S. L. Penfield and H. L. Wells, who were at that time graduate students in the Scientific School. Penfield later became assistant to Brush and finally succeeded him as acting professor of mineralogy

when administration duties compelled the latter to relinquish his teaching.

Brush also did much important work along the lines of the systematization of mineralogy. He wrote the eighth, ninth and tenth supplements to the 4th edition of Dana's "System of Mineralogy." He assisted in the preparation of the 5th edition of that book and wrote its first appendix. In 1874 he published his "Determinative Mineralogy and Blowpipe Analysis," a book which passed through fourteen editions until 1898 when it was revised by S. L. Penfield.

He commenced to assemble a mineral collection when a boy of fifteen years of age. His first specimen, which is still preserved, was collected at Salisbury, Connecticut, in 1846. This was the nucleus of what has since grown to be a collection of more than fifteen thousand specimens. The Brush Mineral Collection, as it is called, is in many ways unique. The idea that its founder always had in mind was to make it a collection for study rather than one for exhibition. It does not include, therefore, as many large or striking specimens as some of our public collections, but is, on the other hand, particularly rich in representative and type material. It is the repository of most of the minerals which have been the subject of investigation at Yale during the last forty years. From the viewpoint of the student of mineralogy, therefore, it ranks high among the mineral collections of the world. Together with a large mineralogical library it was given to the Sheffield Scientific School in 1904 accompanied with an endowment fund to provide for its future maintenance. The Brush Mineral Collection will therefore always remain one of the treasures of Yale and form a notable monument to its founder.

Professor Brush was elected a member of the National Academy of Sciences in 1868 and received the degree of Doctor of Laws from Harvard University in 1886. He was president of the American Association for the Advancement of Science in 1880. He was an honorary member of the Mineralogical Society of England, was a foreign member of

the Geological Society of London, of the Geological Society of Edinburgh, of the Royal Bavarian Academy of Sciences of Munich and various other learned societies, both at home and abroad.

It is seldom that we have a man of such wide influence along so many different lines who can combine, as he did, the activities of the scientific investigator, the duties of the organizer and the services of the public-spirited citizen. His character, combining, as it did, the scientist's demand for truth and accuracy with the kindly spirit of the broad-minded gentleman, was an inspiration to all who knew him. His optimism, his generous nature, and his readiness to serve were qualities that endeared him to his colleagues and to the many students with whom he came in personal contact.

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Vol. 17, p. 359; Vol. 18, p. 45; Vol. 20, pp. 257, 351; Vol. 39, p. 201.

1880. "On the Relation of Childrenite and Eosphorite" (with Edward S. Dana), *Amer. Jour. Sci.*, Vol. 19, p. 316.
- "On Crystallized Danburite from Russell, N. Y." (with Edward S. Dana), *Amer. Jour. Sci.*, Vol. 20, p. 111.
1881. "On American Sulpho-selenides of Mercury," *Amer. Jour. Sci.*, Vol. 21, p. 312.
1883. "On Scovillite" (with Samuel L. Penfield), *Amer. Jour. Sci.*, Vol. 25, p. 459.

WILLIAM E. FORD¹

THE RAINEY AFRICAN EXPEDITION

MR. EDMUND HELLER, who represented the Smithsonian Institution on Mr. Paul J. Rainey's African Expedition, writes from Kisumu, British East Africa, January 26, 1912, that the expedition has been completed but that a delay has been caused in the shipment of specimens collected by Mr. Rainey and himself, due to the lack of porters, transportation facilities, etc. The collection, which arrived at Nairobi two weeks prior to the date of his letter, has been packed and forwarded by him to the Smithsonian Institution. While waiting for a steamer from Mombasa, Mr. Heller put in a couple of months in making collections at various stations of the Uganda Railroad, including some districts not touched by the Smithsonian Expedition under Colonel Roosevelt, and also about Lake Victoria Nyanza. By this means he has been able to add many species to the Smithsonian collection, as well as to finish a really complete survey of the mammals of British East Africa. He will probably spend a few weeks at the British Museum, and at the Berlin Museum, in comparing and identifying some of the specimens collected. The trip was most satisfactory in every way, and Mr. Heller estimates that the collection will rival that made by the Smithsonian African Expedition under Mr. Roosevelt in 1909 and 1910. In all there are about 700 large mammal skins in salt, 4,000 small mammal skins, and a large number of

¹ Assistant professor of mineralogy in the Sheffield Scientific School of Yale University and curator of the Brush Mineral Collection.

birds and reptiles, most of them coming from regions not visited by the previous expedition, while some are from remote localities never before visited by naturalists. After the completion of his studies in Europe, Mr. Heller will return to Washington, to complete his report on the mammals of British East Africa.

THE PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

THE second annual meeting of the Pacific Association of Scientific Societies will be held at Stanford University on April 4, 5, 6, 1912. Sessions will be held this year on one or more of the above days by the following eight societies:

- The Technical Society of the Pacific Coast.
- The Cordilleran Section of the Geological Society of America.
- The Seismological Society of America.
- Pacific Coast Branch of the American Historical Association.
- The Pacific Slope Association of Economic Entomologists.
- Pacific Paleontological Society.
- The Biological Society of the Pacific.
- The California Section of the American Chemical Society.

There will also meet with the Association the LeConte Club and the Mathematical Society of the Pacific Coast.

Friday evening will be used generally for dinners and banquets, and on Saturday evening will be held the general session of the association. President Jordan will give the address of welcome, and among the readers of papers will be Professor A. C. Lawson, University of California, Professor George Hemphill, Stanford University, and Director W. W. Campbell, of the Lick Observatory.

The Pacific Association of Scientific Societies was organized in 1910 "to promote co-operation among the constituent societies." It is to make possible the getting together of a number of smaller isolated societies annually at the same time and place. The administrative machinery of the association is an Executive Committee composed of the presidents and secretaries, or their representatives, of the constituent societies. The principal business of this committee is to suggest

time and place of meeting and make arrangements for such meetings.

Nine Coast Societies became members the first year:

- The Technical Society of the Pacific coast.
- The Cordilleran Section of the Geological Society of America.
- The Seismological Society of America.
- Pacific Coast Branch of the American Historical Association.
- The Pacific Slope Association of Economic Entomologists.
- Pacific Coast Paleontological Society.
- The Philological Society of the Pacific Coast.
- The Cooper Ornithological Club.
- California Academy of Sciences.

The second year two more societies became members:

- The Biological Society of the Pacific.
- The California Section of the American Chemical Society.

The present officers of the association are:
Chairman of the Executive Committee, Mr. Otto von Geldern.

Vice-chairman, Professor George D. Louderback.
Secretary-treasurer, Professor J. N. Bowman.

The first meeting of the association was held at the University of California on March 31-April 1, 1911. The different societies accepting the suggested time and place, held their sessions on the campus; on Saturday evening the general session of the association convened in California Hall. At this session addresses and papers were given by Chairman Otto von Geldern, President Benjamin Ide Wheeler, President David Starr Jordan, Professor Vernon Kellogg, Mr. George W. Dickie and Professor Bernard Moses. The same general plan will be followed this year at the second annual meeting at Stanford University. The work of the various secretaries is greatly facilitated by the committee on arrangements appointed by President Jordan and composed of Professors Townley, Heath and Burlingame.

SCIENTIFIC NOTES AND NEWS

MR. SAMUEL HENSHAW has been appointed director of the Museum of Comparative Zoology of Harvard University.

PROFESSOR CHARLES JAMES, of New Hampshire College, has been awarded the Nichols medal of the American Chemical Society.

DR. A. E. ORTMANN, curator of invertebrate zoology, Carnegie Museum, and professor of physical geography, University of Pittsburgh, has been elected a member of the Halle Academy of Sciences.

MR. GUGLIELMO MARCONI has been appointed a life senator by the Italian government.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Professor J. O. Arnold, Professor C. G. Barkla, Mr. L. Cockayne, Mr. A. L. Bixon, Sir T. L. Heath, Dr. H. O. Jones, Professor T. R. Lyle, Dr. W. McDougall, Mr. R. Messel, Professor B. Moore, Mr. E. Nettleship, Mr. R. Newstead, Vice-Admiral Sir H. J. Oram, Dr. G. T. Prior and Mr. R. C. Punnett.

THE following have been appointed members of the American Commission on Inorganic Nomenclature of Chemistry, to co-operate with similar national bodies of other countries: Jas. Lewis Howe, of Washington and Lee University, chairman; P. E. Browning, of Yale; E. C. Franklin, of the Hygienic Laboratory, Washington; A. M. Patterson, Xenia, O.; Chas. H. Herty, of the University of North Carolina; Owen Shinn, of the University of Pennsylvania, and Adolf Law Voge, of the Library of Congress.

AT its last meeting the Rumford committee of the American Academy of Arts and Sciences granted the sum of \$250 additional to a former appropriation to Professor Gilbert N. Lewis, of the Massachusetts Institute of Technology, in aid of his research upon the free energy changes in chemical reactions.

RECENT appointments to the research staff of the Otho S. A. Sprague Memorial Institute, Chicago, are Dr. Lydia M. DeWitt, formerly of the department of anatomy at the University of Michigan, and more recently of the health department of the city of St. Louis, and Dr. Samuel Amberg, of the department of pediatrics at Johns Hopkins Medical School.

DR. R. RAMSAY WRIGHT, vice-president of the University of Toronto and dean of the faculty of arts, will retire from active service on September 30. He has filled the chair of biology for the last thirty-eight years.

PROFESSOR EDWARD HICKING JACKSON, professor of orthopedic surgery at the Harvard Medical School, and Professor James Jackson Putnam, professor of diseases of the nervous system, have retired from active service and will be given the title of professor emeritus.

MR. N. E. DORSEY, Ph.D. (Hopkins, 1897), associate physicist in the U. S. Bureau of Standards, has been appointed research associate in the department of terrestrial magnetism of the Carnegie Institution of Washington.

DR. GEORGE A. HULETT, professor of physical chemistry, at Princeton University, has received leave of absence for the academic year 1912-13, in order that he may accept, for the year, the post of chief chemist in the U. S. Bureau of Mines.

MISS MARGARET HARWOOD, of the Harvard College Observatory, has been appointed to the astronomical fellowship of the Nantucket Maria Mitchell Association.

PROFESSOR W. BALDWIN SPENCER, F.R.S., has been appointed protector of the aborigines in the northern territory of Australia.

DR. SCHLAGINHAUFER has been chosen as the successor of Dr. R. Martin at the head of the Anthropological Institute, Zurich.

DR. W. J. HOLLAND, director of the Carnegie Institute, Pittsburgh, has been appointed by the Entomological Society of London to represent it at the centenary of the Academy of Natural Sciences of Philadelphia.

DR. A. HRDLICKA has been designated as the representative of the Smithsonian Institution at the eighteenth International Congress of Americanists, to be held at London from May 27 to June 1, 1912. Dr. Hrdlicka has also been accredited as a delegate to the congress on the part of the United States.

DR. C. H. EIGENMANN, curator of ichthyology at the Carnegie Museum, reports himself

as highly successful in his exploration of the Rio Magdalena and the Rio Atrato, in which he is making large collections of fishes for the museum.

MRS. T. D. A. COCKERELL has just returned from Guatemala, where she collected both in the mountains and in the tropical lowlands, and obtained a large collection of bees and other insects, as well as some reptiles, fishes, plants, etc.

DR. LOUISE B. WALLACE, associate professor of zoology at Mt. Holyoke College, has been granted two years leave of absence to take charge of the biological department in the American College for Girls in Constantinople.

DR. MAX BORN, of the University of Göttingen, is to lecture on relativity during the summer quarter at the University of Chicago. The course is to continue throughout the entire quarter.

PRESIDENT F. P. VENABLE, of the University of North Carolina, lectured before the Chemical Society of Washington and Lee University on March 1, on "The Value of Chemical Research."

DR. M. P. RAVENEL, of the department of bacteriology of the University of Wisconsin, is delivering a series of six lectures before the Milwaukee Medical Society on "Studies in Immunity, Vaccine and Serum Therapy."

PROFESSOR LAFAYETTE B. MENDEL, of the Sheffield Scientific School of Yale University, lectured before the students of Mt. Holyoke College on March 2, on "Changing Views on Nutrition."

At a meeting of the Geographical Society of Chicago on March 8, a lecture was given by Mr. Alfred H. Brooks of the U. S. Geological Survey, the title of the lecture being "Geography of Alaska."

PROFESSOR J. G. D. MACK, the exchange lecturer from the University of Wisconsin, gave two lectures before the students and faculty of the College of Engineering of the University of Illinois on February 29. One lecture was on the engineering features of the Wisconsin Tax and Public Utilities Com-

missions. Professor Mack is a member of the engineering staff of these commissions. The second lecture was on some features of ancient engineering work and their relations to present-day practise, and was, in part, an appeal to engineering students to study the history of engineering as well as current practise.

DR. LYNDS JONES, associate professor of animal ecology in Oberlin College, lectured recently before the undergraduates in Spear Laboratory upon "The Winter Birds of Ohio." From now on to the end of the college year Dr. Jones is offering a seminar in practical field work in ornithology which has been elected by about ten advanced students.

DR. JOHN BERNHARDT SMITH, state entomologist of New Jersey and professor of entomology at Rutgers College, eminent for his contributions to entomology, died on March 12, aged fifty-four years.

PROFESSOR MASON BLANCHARD THOMAS, B.S. Cornell '90, Ph.D. '07, professor of botany at Wabash college since 1891, and dean of the faculty since 1907, died at Crawfordsville, Ind., on March 6, aged forty-six years.

DR. SAMUEL AUGHEY died in Spokane, Washington, on February 3, 1912, at the age of eighty-one. He was a graduate of Pennsylvania College, Gettysburg, and of the Theological Seminary of the same place. After some years in the ministry, during which time he moved with his family to Nebraska and soon became noted as an enthusiastic naturalist, he was elected to the chair of natural science in the newly established State University of Nebraska, where he remained for thirteen years. On severing his connection with the university, he devoted himself more especially to geology and the practical work of the mining expert. Among his publications are "A Catalogue of the Flora of Nebraska" (1875); "Physical Geography and Geology of Nebraska" (1880); "Geological Report on the Wyoming Oil Basins" (1881), etc.

PROFESSOR OSBORNE REYNOLDS, the distinguished engineer and physicist, for many years professor at the Owens College, died on February 21, aged seventy years.

SIR JOHN G. N. ALLEYNE, Bt., known as an authority in engineering and for his interest in iron and steel research, has died in his ninety-second year.

DR. A. H. YOUNG, emeritus professor of anatomy in the University of Manchester, died on February 22.

PROFESSOR RICHARD ANDRÉE, of Leipzig, known for his work in geography and ethnography, has died at the age of seventy-seven years.

THERE is existing a vacancy in the position of chief engineer, Indian Irrigation Service, at a salary of \$4,000 per annum. The requirements of the position are technical in their nature, the work having to do with the planning and construction of all the irrigation work under the control of the Office of Indian Affairs. The government is endeavoring to find the best man available for this work, and has no particular individual in view. The qualifications and fitness for this position, based upon education, training and experience in the design and construction of engineering works, will be determined by a board of experienced engineers. Qualified persons who are interested in this position are invited to communicate with the U. S. Civil Service Commission, Washington, D. C. The commission also announces a vacancy in the position of research bacteriologist in the biological laboratory of the Bureau of Science, Manila, Philippine Islands, at a salary of \$2,500 a year. This position is for a research bacteriologist with clinical experience, and applicants must be graduates in medicine; in addition they must show that they have specialized extensively in bacteriology and are capable of doing original research work. The work comprises investigations in tropical medicine in conjunction with the chief of the biological laboratory, who is also professor of tropical medicine in the College of Medicine and Surgery. The clinical material of the Philippine General Hospital and the hospital of the government prison will be available for study in connection with bacteriological investigation. It is stated by the Bureau of Science that opportunities exist for promotion

to higher places as vacancies occur, and at present there are six positions in this laboratory above the one in question, at salaries ranging from \$2,500 to \$5,000 a year. The library of the Bureau of Science and the equipment are of the very best and strictly modern, so that this position offers a unique opportunity for a young man who is ambitious to do research work.

THE treasurer of Columbia University has reported to the trustees that he had received about \$1,550,000 from the executors of the estate of the late George Crocker. Accordingly, the work of cancer research, for which Mr. Crocker gave this sum as an endowment, will begin at once. The research fund will be intrusted for administration to a board of managers, to consist of Mr. Rives, Dr. Cheesman and President Butler from the trustees, and Dean Lambert, Professors Janeway and MacCallum, of the medical faculty, together with a director of Cancer Research to be appointed.

THE Scripps Institution for Biological Research at San Diego is about to be made a part of the University of California. It was built up through the aid of Miss Ellen B. Scripps and Mr. E. W. Scripps. Control, heretofore in the hands of the San Diego Marine Biological Association, will be delegated by the University to Miss Ellen B. Scripps, Mr. E. W. Scripps, President Benjamin Ide Wheeler, of the university, and Dr. William E. Ritter, professor of zoology and director of the Scripps institution.

UNIVERSITY AND EDUCATIONAL NEWS

THE Brown University endowment fund has received a gift of \$10,000 from Mr. J. B. F. Herreshoff, an alumnus, vice-president of the Nichols Chemical Company of New York. This makes \$762,417 towards the million dollar fund.

THE budget of Columbia University calls for the expenditure of \$3,159,730.28 during the year beginning July 1. It is estimated that the income for the same period will fall short of meeting the expenditure by \$132,000, de-

spite the fact that the income on a large part of the John Stewart Kennedy bequest is now available. The largest single item of expense is for educational administration and instruction, \$2,180,402. Next to this come appropriations for buildings and grounds, the sum being \$332,593. The interest on the corporate debt will amount to \$114,870, while \$100,000 will be set aside and added to the redemption fund. Stated according to the various corporations of the university, the budget is divided as follows: Columbia College, \$2,101,512.28; Barnard College, \$217,725; Teachers College, \$803,470; College of Pharmacy, \$37,020.

A SPECIAL meeting of the Oberlin trustees was held on March 13 to consider plans presented by Mr. Cass Gilbert, of New York City, regarding the location of the new buildings made possible by the completion of the half million endowment. Mr. Gilbert's plans include a science quadrangle at the northwest end of the campus. Here it is proposed to erect four large laboratories to accommodate the departments of physics, zoology, geology and botany. Part of the equipment of the botanical building will be a series of greenhouses. The department of chemistry is already comfortably housed in a separate building, Severance Chemical Laboratory.

DR. HORACE DAVID ARNOLD has been appointed dean of the Harvard Medical School to fill the place made vacant by the resignation of Dr. Henry A. Christian.

DR. TALCOTT WILLIAMS, associate editor of the *Philadelphia Press*, has been appointed director of the School of Journalism of Columbia University, founded by Mr. Pulitzer. Professor John W. Cunliffe, now head of the department of English of the University of Wisconsin, is the associate director of the school.

DR. DOUGLAS W. JOHNSON, assistant professor of physiography in Harvard University, has been appointed associate professor of physiography at Columbia University.

DR. J. E. WALLACE WALLIN has accepted a

call from the University of Pittsburgh to organize a department of clinical psychology.

DR. MURRAY S. WILDMAN, A.B. (Earlham, '93), Ph.D. (Chicago, 04), now professor of economics and commerce in Northwestern University, has been appointed professor of economics in the Leland Stanford Jr. University, to fill the vacancy caused by the resignation of Professor Alvin S. Johnson, who goes to Cornell University at the close of the present academic year.

DR. H. W. FOOTE has been promoted to be professor of physical chemistry in the Sheffield Scientific School of Yale University.

DISCUSSION AND CORRESPONDENCE

THE CORN SNAKE IN NEW JERSEY

WHILE at Chatsworth, Burlington County, N. J., on July 11, 1911, I called on Mr. George Bozarth, the hotelkeeper, who buys up local snakes, excepting rattlesnakes, of which there are still a few in that part of the pine barrens. Noting that the box where he kept his reptiles contained only pine and king snakes, I inquired if he had any other species. He replied that he had but the day before thrown out a corn snake, which had died. He added he had but few of that kind brought in, but that they were to be occasionally met with in the vicinity. After some search we found the reptile, which was still in a good state of preservation and which I showed to various people living near Jones's Mill, a short distance to the east of Chatsworth, eliciting the information that the corn snake occurred in the vicinity, but was far rarer than the pine snake.

My specimen has the dorsal rows of scales weakly keeled, as described by Cope, and the color pattern also fits the description admirably. It has also been compared with living specimens in the New York Zoological Park. It is thirty-four inches in length.

In the "Amphibians and Reptiles of New Jersey," by Henry W. Fowler, published in the Annual Report of the New Jersey State Museum for 1906, I do not find the corn snake, *Coluber guttatus* Linn., recorded, nor

is it mentioned in the supplements that have since been published. Cope says:

This species ranges the Austroriparian region east of the Mississippi River, and the Carolinian district of the Eastern, not, however, entering New Jersey.

It appears, however, from the above record that there is at least one colony of corn snakes to be found in the pine barrens of New Jersey.

NEW BRIGHTON,

WM. T. DAVIS

STATEN ISLAND, N. Y.

FUNDULUS AND FRESH WATER

THE notes which have recently appeared in SCIENCE in regard to the capacity of salt-water minnows to survive being transferred to fresh water, remind me that the experiment has been, and I suppose still is tried, on what I may call a commercial scale, in southeastern Massachusetts. "Mummichugs" (*Fundulus* spp.) are the favorite, practically the only, bait for winter pickerel fishing through the ice, and it was a very common practise to catch them in large quantities in salt water in the late fall, and keep them in running fresh water all winter.

When I lived on a farm in Middleboro, Mass., in 1892-96, one of my neighbors always had them for sale, during the pickerel season. He used to catch them in Buzzard's Bay, some fifteen miles away, and kept them in a perforated box, placed in a running brook. I have more than once bought "Mummichugs" from him, and, if my memory does not play me false, have kept them alive for some time in a boxed-in spring on my farm. They must have been in confinement at least a month, but seemed in perfect health and were very vigorous and active. Had there been any serious mortality among them, it certainly would not have paid him to keep them for sale.

As a matter of fact, I believe that live *Fundulus* for bait are to be had regularly in the Boston fish markets every winter, and my impression is that they are kept in tanks fed with ordinary tap water.

I may add that I use a good many "Mum-

michugs" for live bait every summer, and find them remarkably tenacious of life. If covered with wet seaweed, they keep lively for several hours even in hot weather.

JOHN MURDOCH

PUBLIC LIBRARY,

BOSTON, MASS.

SCIENTIFIC BOOKS

Vergleichende Physiologie. By AUGUST PÜTTER. Jena, G. Fischer. 1911. Pp. 721; illustrations 174.

The title of this book, "Comparative Physiology," is misleading and the author, who is a professor at Bonn, endeavors to justify it in his introduction. The task of general physiology, he says, is the investigation of the general problems of life; comparative physiology is a method, the object of which is to enable one to comprehend the fundamental physiological similarities of organisms. The book therefore does not rehearse the physiological differences of species or larger groups, but deals with general physiology. "Allgemeine Physiologie" would have been a better title, had it not conflicted with that of his master Verworn's book. The facts are drawn chiefly from invertebrate animals and plants, a helpful list of which, with both scientific and common names, family, order and class, is given at the end. There are ten chapters, most of them long, rambling, and clumsily subdivided. In one case, the same heading is used for two distinct and separate sections. The index is wretchedly incomplete. Notwithstanding these technical defects, the book is a valuable addition to the growing literature of general physiology. It is very modern: most of its references to literature belong to the last decade; but again the great bulk of American physiology is unnoticed.

The morphological substratum of vital processes is passed over very briefly, only a few facts being presented regarding colloids, adsorption compounds, membranes, alveolar structure, and the chemical constituents of living substance. The term "living substance" is an abstraction; several kinds of

living substance are always combined to form a living system. The simplest living system is the cell, which comprises at least three structural substances, plasm, nucleus and membrane. More than one quarter of the text is devoted to metabolism. Here the author's tendency to avoid the conventional, which is evident throughout the book, is at once illustrated by his sharp separation between "Baustoffwechsel," and "Betriebsstoffwechsel," comprising respectively the metabolic processes involved in the building of body substance and those not so involved. The actions on metabolism of such conditions as temperature, light, altered concentration of food stuffs, hunger, absence of oxygen, and accumulated metabolic products are discussed. In a subsequent chapter on nutrition, the author presents with experimental evidence his theory that many aquatic animals are nourished by organic food dissolved in the surrounding water, and maintains that this has now been proved for many coelenterates, entomostracans, tunicates and some fishes. Resorption is discussed from the modern standpoint. The chapter headed "Exchange of Matter," allows a modern treatment of such general physiological topics as the resorption of oxygen and of solid substances in solution, the exchange of water, excretion, secretion, and the distribution of matter in plants and animals. Here many of the facts and principles of respiration, excretion and circulation are introduced, but there is no attempt to treat these topics along the conventional lines of vertebrate physiology. The chapter on the conditions of life ends with a discussion of the problem of the duration of life, with references to the work of Calkins and of Woodruff.

A separate chapter is devoted to transformations of energy and includes mechanical and chemical energy, light, electricity and heat. The author accepts Hürthle's ideas regarding the structure of muscle and, following Koltzoff's general conception of the relations of plasm and fibrillæ, believes the fibrillar rods to be elastic bodies which are under tension when the muscle is at rest. In contraction

there occurs a sudden change in the osmotic relations of the sarcoplasm and the isotropic disk, either a decrease of osmotic pressure in the former, or an increase in the latter; the membrane between the two undergoes an increase in permeability; water passes from the sarcoplasm to the isotropic substance; and the elastic tension of the fibrillar rods is released. Fröhlich's view of tonus is followed, according to which tonus represents a slight tendency to continuous contraction of a relatively small number of the fibers of a highly irritable muscle, resulting from the action of very feeble stimuli coming from nerve tissue. Contracture, on the other hand, is a purely muscular condition present in fatigued, narcotized and asphyxiated muscle, and represents a partial inability of all the muscle fibers to extend their elastic elements. The cilium, like the muscle fiber, contains an elastic and a plasmic constituent, and the interactions of the two result in the ciliary movement. Amœboid movement is probably similar in principle, the elastic element perhaps being represented by the superficial layer of the amœboid cell. The increase in the permeability of the plasmic membrane that occurs during contraction is associated with a reversible coagulation resulting from the action of the stimulus on metabolic processes.

Under the general heading of responses to stimuli the author discusses many of the current topics of general physiology, such as irritability, the law of the threshold of stimulation, the all-or-nothing law, conduction, the latent period, fatigue, the *treppe*, the refractory period, spontaneity, taxis and tropism, tonus, rhythm and the question of its myogenic or neurogenic origin, and the relation between irritability and metabolism. In many of these the author shows himself to be under the influence of the school of general physiology that is headed by Verworn. Sense organs are treated in a broad manner, attention being given not only to the various special senses of animals, but to analogous mechanisms in plants, such as the ocelli in leaves and the static relations of starch grains. In discussing the possibility of hearing by fishes a

warning is pronounced against a too wide generalization of the fact that a few species of fishes have been proved to react to tones. Sections are devoted to the chemical senses, with special reference to investigations on invertebrates, and to unknown senses.

It is in the treatment of the nervous system that the author breaks farthest away from conventional paths and takes a partisan stand on debatable ground. The neurone theory is not accepted, but throughout the whole nervous system there is a complete continuity of living substance. Neurofibrillæ are merely the skeleton of the nerve cell; the neuroplasm is the conducting part. Poisons have revealed the presence of at least six different kinds of living substance in the nervous system: the irritability of the end-organs of cross-striated muscle, of the end-organs of glands, the cardiac branches of the vagus nerve and of smooth muscle, and of sympathetic ganglion cells being depressed by curare, atropin and nicotin, respectively; the irritability of motor cells, intercalated cells and sense cells being augmented respectively by phenol, by strychnine and by neither phenol nor strychnine. Motor differ from non-motor cells in possessing less fatiguability, less need of oxygen and less sensitiveness toward narcotics. The central type of nerve substance is sharply differentiated from the peripheral type by various characteristics, such as its power of summation, certain peculiarities of its conductivity, its greater tendency toward fatigue and its greater need of oxygen—all of these differences, however, being quantitative and capable of being overcome by experimental devices. The author discusses the "adequate," or normal, stimuli for the successive nerve elements that partake in a reflex action, and raises the question whether internal secretions may not constitute the adequate stimuli for the cells of the sympathetic system. Reflex actions are discussed and numerous examples are cited to illustrate their principles. Brief sections are devoted to tonus, to inhibition, as to the theory of which no definite stand is taken, and to instincts; and the chapter ends with a dis-

cussion of the motor reactions of animals, which cites Yerkes's work. The final chapter deals with a comparison of organisms.

FREDERIC S. LEE

COLUMBIA UNIVERSITY

Star Lore of All Ages. By WILLIAM TYLER OLCOTT. G. P. Putnam's Sons. 1911. Pp. xxii + 453, illustrated.

The star groups or constellations, so fantastically figured in the ancient maps, are of unknown antiquity; they are found described in the earliest writers of the Greeks, and upon the tablets of Babylon. Around each group has collected a vast number of traditions, myths and legends; and these traditions Mr. Olcott has traced to their sources, the legends and myths he has collated, and has put all into a very readable form. The book is most attractively printed and illustrated and should be of interest to all who like to watch the stars.

CHARLES LANE POOR

COLUMBIA UNIVERSITY

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of volume 13 of the *Transactions of the American Mathematical Society* contains the following papers:

E. Landau: "Ueber eine idealtheoretische Funktion."

R. G. D. Richardson: "Theorems of oscillation for two linear differential equations of the second order with two parameters."

E. J. Miles: "The absolute minimum of a definite integral in a special field."

E. G. Bill: "An existence theorem for a problem of the calculus of variations in space."

L. E. Dickson: "Linear algebras."

R. L. Moore: "A note concerning Veblen's axioms for geometry."

Joseph Lipke: "Natural families of curves in a general curved space of n dimensions."

F. R. Moulton: "A class of periodic orbits of superior planets."

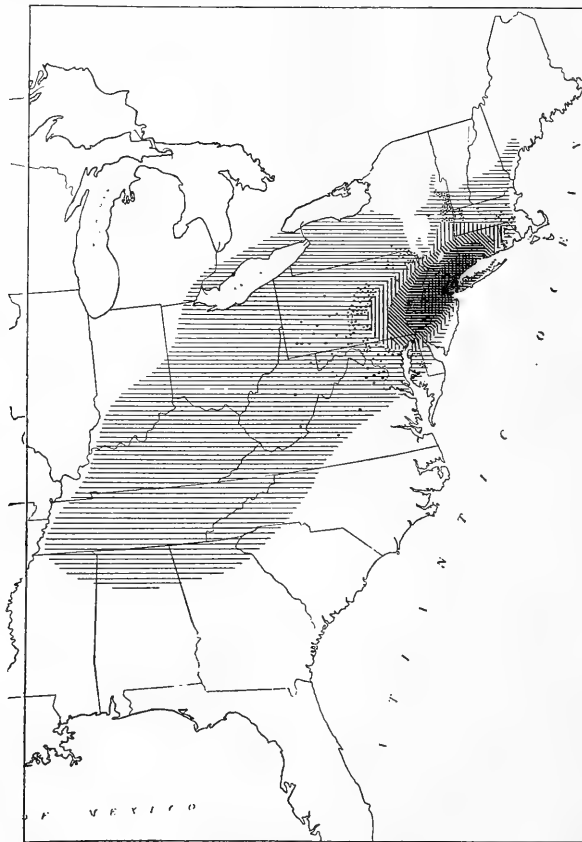
O. D. Kellogg: "Harmonic functions and Green's integral."

THE February number (volume 18, number 5) of the *Bulletin of the American Mathe-*

matical Society contains: Reports of the eighteenth annual meeting of the society and of the fifth regular meeting of the South-western Section, by the secretaries; "Series of Laplace's functions," by B. H. Camp; "On a new mixed problem of the partial differential equation of telegraphy," by A. G. Webster; "Non-Euclidean geometry" (review of Sommerville's "Bibliography of Non-Euclidean

Geometry"), by R. C. Archibald; "Notes"; "New Publications."

THE first number of a new architectural journal, entitled the *Architectural Quarterly of Harvard University*, will be published this month. The purpose of the periodical is to present in easily accessible form important work by students, special lectures delivered in the school, and contributions by members of



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the teaching staff and graduates. The principal article in the first number will be an illustrated paper on "Architectural Acoustics" by Professor W. C. Sabine, with a practical discussion of a number of recent theaters, lecture halls and churches. The number will also contain several drawings of important examples of European architecture and an essay on "The Mediaeval Town Halls of Italy" by H. E. Warren, S.M. in *Architecture*, 1905. Early numbers of the *Quarterly* will contain examples of recent work in architectural design by students of the school, a paper on professional practise, the substance of three lectures recently delivered before the school by Mr. Cass Gilbert, of New York (lately president of the American Institute of Architects), and papers on the teaching of architectural design by Professor Duquesne, on the study of architectural history in its relation to the professional study of architecture by Professor H. L. Warren, and further papers on acoustics by Professor Sabine.

THE PRESENT KNOWN DISTRIBUTION OF THE CHESTNUT BARK DISEASE.

The writers published in *Farmers' Bulletin* 467, page 6 (issued October 28, 1911), a map showing the distribution of the chestnut bark disease as known in June, 1911. Since that time the disease has spread considerably, also our detailed knowledge of its distribution has increased. In the map here published, thin horizontal lines show the general distribution of uninfected *Castanea dentata*. Thick lines variously arranged in concentric bands indicate general regions of gradually increasing infection which culminate in the region of practically complete destruction of the tree about New York City. Black dots represent the location of advance infections, many of which have already been eradicated. The writers are under obligations to Dr. Perley Spaulding, Professor A. H. Graves, Mr. I. C. Williams, Mr. S. B. Detwiler and the members and employees of the Chestnut Tree Blight Commission of Pennsylvania, Mr. W. H. Rankin, Mr. J. F. O'Byrne, Mr. F. W. Besley, Dr. Ernest S. Reynolds, Mr. H. G.

MacMillan, Professor H. R. Fulton and Mr. A. B. Brooks, for much of the data used in compiling this map.

HAVEN METCALF,

J. FRANKLIN COLLINS

OFFICE OF FOREST PATHOLOGY,

BUREAU OF PLANT INDUSTRY,

WASHINGTON, D. C., February 1, 1912

SPECIAL ARTICLES

SENILITY IN MERISTEMATIC TISSUE

MERISTEMATIC tissue in perennial plants is commonly believed to retain its embryonic condition unchanged. Senility is considered to occur only in specialized cells. A twig cut from a mature tree and planted or grafted is said to produce a new tree as youthful in its protoplasmic vigor as a seedling. While these are almost the unanimous opinions of the botanists, it is interesting to note that many fruit growers and gardeners have always held that vegetatively propagated plants tended to run out, as if through senility.

In order to determine, if possible, which of these views is better justified, a series of investigations on meristematic tissue in perennials of different ages have been carried out, and this article is a brief preliminary statement of one of the more obvious results.

The structure of the adult leaves gives valuable insight into the meristematic tissue, since any minute changes occurring in the latter will be made larger and more obvious in the leaves, just as the inherent characteristics of seeds become more apparent in the plants into which they grow. If, therefore, the meristematic tissue of a perennial is changing with the increasing age of the plant, the new leaves appearing each year should reveal differences. In order to eliminate differences due to external factors, leaves were taken from cuttings of *Vitis riparia* of different ages grown under identical conditions. Comparisons were also made between leaves borne by vines growing wild, side by side under apparently identical conditions, and on many other kinds of trees and vines.

An interesting condition in the venation of the compared leaves was one of the results

noted and seemed to merit this preliminary note, because of the ease with which it may be recognized without apparatus by fruit growers as well as by botanists.

The smallest veinlets of the leaf form a continuous network and the meshes of this network are areas of parenchymatous tissue. The size of these areas is not only remarkably uniform in a mature leaf but is directly dependent upon the age of the plant upon which the leaf is growing. The older the plant, the smaller are the vein-areas of the leaf. This difference can be seen with a hand lens by holding the leaves up to the light. In *Vitis riparia*, for example, accurate measurements of hundreds of areas in leaves picked from different parts of the same vine, gave an average (vine 26 years old) area of .20398 sq. mm., while the largest measured .217 sq. mm. and the smallest .185 sq. mm. The comparison for leaves from vines of different ages is shown by the following table, which gives averages from leaves picked from many plants.

	4-5 Growth Rings.	6-12 G. R.	15-20.	35-50.
Cuttings of <i>V. riparia</i>...	.44 sq. mm.	.35	.29	
Wild vines of <i>V. riparia</i> .	.42	.33	.24	.16

Even where the leaves are very large, as in the case of those borne on water-shoots from living stumps, the size of the areas is that characteristic of leaves borne on the tree the age of the stump. One of the several series of this kind follows:

Tree of <i>Castanea dentata</i>	8 Rings	15 R., Water- shoot	30 R.	Tree 50 R.
Size of area	.07 sq. mm.	.05 sq. mm.	.04 sq. mm.	.03 sq. mm.

The results with cuttings, water shoots and selected vines plainly indicates that the difference in size of areas is not due to external conditions. The reason that a leaf from a tree 25 years old differs in its venation from a leaf of a tree 10 years old is therefore that the meristematic tissue, in the two trees of the same species growing under the same conditions, is different. Apparently the meristem of the older tree produces less efficient spe-

cialized tissues than does the younger. The parenchyma is less permeable, the vessels less efficient in conducting; the sap must be brought into closer contact with all the leaf protoplasm. Since the amount of carbohydrate producing parenchyma is being gradually decreased by the inroads of the conducting system, the leaf is becoming a less efficient manufacturer of carbohydrate and ultimately the plant must starve.

If the changes in the size of the vein-areas be plotted as a curve, the nature of the resulting curve is the same as when the recognized senility changes in man and animals are plotted. It is interesting to note that changes in the vascular system in plants are due to the increasing senility of the meristem, just as changes in the vascular system of animals are due to senility. Dr. Osler says that "a man is as old as his arteries," and it may be said of plants that they are as old as their veins.

Since the leaves borne by cuttings showed but slight increase in the proportion of carbohydrate-producing tissue as compared with those on the original plant, it would appear that vegetative propagation can not and does not produce a young plant. The fact that the normal span of life for woody trees and vines extends in some cases over hundreds of years accounts for the fact that the approach of senility in vegetatively propagated plants is not more obvious. Plants which naturally reproduce by seed will tend to "run out" after long-continued vegetative propagation, ultimately dying of senility, and it is therefore incumbent upon our plant breeders to develop new varieties from seed, to take their place.

H. M. BENEDICT

UNIVERSITY OF CINCINNATI

THE WASHINGTON MEETING OF THE AMERICAN CHEMICAL SOCIETY.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL
ENGINEERS

G. D. Rosengarten, *chairman*.

F. E. Gallagher, *secretary*.

H. C. SHERMAN, D. A. BARTLETT and N. E.
WEATHERLESS: *Relation of Ultimate Composi-*
tion to Calorific Power in Coal.

The analyses and calorific powers of 67 coals

from 17 states as published in Professional Paper 48 of the U. S. Geological Survey were considered. Estimates of calorific power by the usual formula

$$x = 8,080 C + 34,500 (H - \frac{1}{8} O) + 2,250 S$$

('Welter's rule')

gave results too low in seven eighths of the cases, the average result being 98.9 per cent. of the calorific power actually found.

The formula

$$x = 8,080 (C - \frac{1}{8} O) + 34,500 H + 2,250 S$$

('Walker's rule')

gave an average result 100.37 per cent. of the calorific power actually determined. The latter formula also showed a smaller proportion of serious errors in individual cases, and a smaller maximum error.

H. C. SHERMAN and S. H. REGESTER: *Relation of Proximate Composition to Calorific Power in Coal*. (Preliminary report.)

Analysis of the data for 500 samples of coal from different parts of the country are averaged to show the general course of the curve for calorific power of dry, ash-free substance with increasing proportions of volatile matter. As the proportion of volatile matter increases the mean deviations of individual samples from the average becomes greater. Where the volatile matter is over 48 per cent. of the dry ash-free substance the individual variations are so great as to deprive the average relation of any appreciable significance. Even with coals of low or moderate proportions of volatile matter, individual samples often differ from the average relation by 2 to 5 per cent. or more, so that if anything more than a crude approximation is desired the calorific power should be determined directly by combustion in a bomb calorimeter.

CHARLES E. MUNROE: *Note on the Production of Mercury Fulminate*.

Describes the preliminary steps taken in the production of substituted fulminic acids from the higher alcohols and of mercury fulminate and these substituted acids from acetaldehyde and the higher aldehydes.

CHARLES E. MUNROE: *The Present Status of the Gas Industry and Its Outlook*.

Attention was called to the fact that the centenary of the gas industry occurs in April, 1912, this being the one hundredth anniversary of the incorporation of the first Gas Light Company in London, England. The industry began in this country with the incorporation of the gas company in Baltimore in 1816. To-day there are 1,296

establishments in the United States, having a capital of \$915,537,000; employing over 50,000 persons; manufacturing 150,835,793 M. cubic feet of gas; and having a value for its products of \$166,814,000. To graphically depict the status and outlook of the industry a brief review of the various difficulties which it has encountered and the competitors which it has met and outranked was given, and it was admitted that the developments in the adaptation of electric energy to use presented now a more critical situation than the gas industry had perhaps ever before encountered; but he found in the development of the gas oven; in the employment of the chemical engineer; in the reduction of heat losses; in the more complete recovery of the by-products and their more complete utilization; and in the discovery and application of flameless incandescent surface combustion, means by which the gas industry could more than hold its own for a considerable time.

G. A. BURRELL: *New Forms of Gas Analysis Apparatus*.

This paper treats of gas analysis apparatus assembled by the author for work having to do with gas investigations carried on by the Bureau of Mines. Both accurate apparatus for use with mercury and apparatus for technical purposes are described. Exact and simple forms of apparatus for the examination of mine air and for use in ventilation studies are also described, both portable and laboratory forms. A special apparatus for the analysis of natural gas is also included. Also new apparatus for determining carbon monoxide by means of the iodic acid method.

F. M. WILLIAMS: *New Forms of Apparatus for Gas Analysis*.

J. T. BAKER: *Problems in Manufacture of C. P. Acids*.

This paper relates to the improvements made in recent years in the forms of apparatus for distilling acids on a larger scale. These are devised for working continuously by feeding the acid into the still as rapidly as the contents distill off and providing a gradual overflow for the tailings in order to remove the non-volatile impurities.

Apparatus made of glass and porcelain are used and have a capacity of from 2,000 pounds to 4,000 pounds distillate in 24 hours. The advantages are less breakage with a minimum amount of labor and consumption of fuel.

J. R. CAIN and J. C. HOSTETTER: *A Rapid Method for the Determination of Vanadium in Steel, Ore, etc., based on its Quantitative Inclusion by the Phosphomolybdate Precipitate*.

Conditions are given for the quantitative precipitation of vanadium from solutions of steel, ores, etc., by coprecipitation with ammonium phosphomolybdate. Some methods of separating the vanadium from the precipitate are described. Attempts to determine the vanadium in the precipitate by Gregory's colorimetric method were unsuccessful. The vanadium may be reduced by sulphurous acid without reducing the molybdenum, and titrated against permanganate, but the method recommended by the authors is to reduce by hydrogen peroxide in concentrated sulphuric acid solution and titrate against permanganate, adhering closely to the conditions prescribed in the paper.

ERNEST BIDTEL: *Valuation of Fluorspar.*

Determinations usually required: Calcium-fluoride, silica, calcium-carbonate, sometimes lead, iron, zinc, sulphur.

Calcium-carbonate is determined by dissolving with ten per cent. acetic acid, taking the solubility of calcium-fluoride into consideration. Residue treated by yellow mercuric oxide to oxidize the sulphides, and silica volatilized by evaporation with hydrofluoric acid; loss in weight is silica.

Calcium-fluoride is eliminated without decomposing the ore. Iron oxide is transformed to iron-fluoride and separated together with lead and zinc sulphate by a solution of ammonium acetate containing ammonium citrate.

L. B. LOCKHART: *The Quality of Commercial Kerosene.*

PERCY A. BOECK: *Notes on a New Form of Extraction Thimble.*

Notes collected from various investigators on a new type of inorganic extraction thimbles and filters known as alundum. Manufacture described. Articles are made from bonded alundum grain, which is the product of the fusion of bauxite in the electric furnace and is practically pure fused alumina. Any texture, filtering capacity, melting point, tensile strength, etc., for any purpose can be obtained by varying method of manufacture. Articles filter rapidly, without any previous preparation and without changing the concentration of the solution, absorb only slightly, require little washing, and can be cleaned and sterilized by dry heating. Several types of extraction and filtering appliances for various kinds of work mentioned.

JOHN P. SIMMONS and O. J. TEEPLE, Jr.: *The Effect of Filtration upon the Physical Properties of Petroleum Oils.*

FREDERIC P. DEWEY: *The Direct Determination of Small Amounts of Platinum in Ores and Bullion.*

Platinum alloyed with silver being soluble in nitric acid, the solution obtained in parting gold from silver in ordinary assays is treated with a limited amount of hydrogen sulphide, after roasting, the precipitate is cupelled with a small amount of lead and the bead parted in strong sulphuric acid. Any platinum present will be left as a white metal, generally recognizable as platinum, but it may be tested to prove its identity or the presence of platinum metals.

FRANKLIN PEALE SUMMERS: *The Product Patent.*

This paper deals with the differences existing between our patent laws and those of the other countries with reference to the product patent on foods, drinks and medicinals. Practically all the other countries with the exception of England and the United States refuse to grant a product patent on the commodities above mentioned. The result is that, first, they permit competition on the necessities of their citizens, and secondly, they encourage the growth of chemistry in the respective countries, by opening and keeping open new fields for chemical research.

As long as these alien countries will not grant to an American citizen the same privilege that the United States grants to their citizens, it does not seem equitable that we should continue to grant the product patent on foods, drinks or medicinals.

In so doing our country continues to retard the growth of chemistry in a field that the other countries keep open. Thus in one product, aspirin, our citizens are annually paying a tribute to Germany of approximately two hundred thousand dollars, over and above what this same commodity sells for in Canada where no product patent is valid. This is due to the fact that in England and Germany the field for the production of acetyl salicylic acid is an open one and competition is permitted.

Were our country to change its patent laws so as to conform with these other countries in this respect, it would open a vast field in the production of organic synthetic compounds. We would be enabled to compete with these countries in an industry whose financial return is many millions of dollars. We would also offer still further inducement for the chemist, and by so doing we would more than ever narrow down the handicap now held by Germany for supremacy in chemical fields.

JAMES O. HANDY: *The Use of Potassium Cyanide Solution in the Investigation of the Structure and Conductivity of Copper, Copper-covered Steel and Other Metals.*

A 25-per-cent. aqueous solution of potassium cyanide dissolves, when boiled, an amount of copper equal to 5 per cent. of the KCy used. Steel and iron are almost insoluble in the same solvent.

Copper containing iron or arsenic shows a characteristic crystalline and colored appearance when etched with KCy solution. Pure cast copper is but slightly affected.

The structure of the "welded on" or "alloyed on" copper coverings of copper-covered steel wire has been studied by means of KCy solution. The "alloyed on" coverings have shown their impure nature. The conductivity of the composite wires and of the bare steel cores (after dissolving off the copper by KCy solution) showed in one case as follows:

	Steel Per Cent.	Copper Per Cent.	Conductivity of Composite Wire Per Cent.
"Welded" ...	77.20	22.80	36.20
"Alloyed" ...	56.00	44.00	34.00

The conductivity of the steel cores approximated 14 per cent. The low conductivity of the sample highest in copper shows its inferiority.

E. P. HARDING and E. JOHNSON: *An Apparatus and Improved Method for Determining Quantitatively Hydrogen Sulfide in Illuminating Gas.*

H. E. KIEFER: *Free Lime in Portland Cement.*

This paper cites numerous experiments to show that free lime is not the sole cause of disintegration of Portland cement as shown by the boiling test. If free lime is a real cause, as little as three tenths of one per cent. will cause rupture. Shows that carbon dioxide is not essential to seasoning and that the absorption of as little as one tenth of one per cent. of water will under certain conditions cure a very defective cement. That under other conditions neither water nor carbon dioxide is essential. Advances a theory of disintegration on physical lines to account for the seasoning of unsound cements.

W. C. TAYLOR and E. C. SULLIVAN: *Glass Analysis.*

A rapid method for analysis of glasses has been developed, depending on the decomposition of the glass by means of hydrofluoric and oxalic acids. Results for alkalis agree very well with those given by the Lawrence Smith method and results for lead, alumina, iron, manganese, lime, magnesia and zinc are accurate also.

The method of Wherry for the determination of boric oxide has been applied to glasses with necessary modifications where zinc or lead is present.

GEORGE L. HEATH: *The Estimation of Absorbed Gases and Oxygen in Copper by Ignition in Carbon Dioxide and Hydrogen.*

Thirty-seven years ago Dr. W. Hampe, of Germany, devised a process for the quantitative estimation of the percentage of oxygen in commercial copper by heating filings, or drillings, in an atmosphere of pure hydrogen gas in a hard-glass bulb tube, determining the loss in weight of the metal, and as an alternative the weight of water produced by the union of the hydrogen with the oxygen existing in the copper. Archbutt, Hofman and the writer have improved the process, but there is an error and omission in all published accounts; which it is important to correct by announcing the results obtained in a recent search for a method to show us, not only the oxygen, but also the original absorbed gases in all refined, or cast, copper of trade, which mainly consists of hydrogen (as hydride, or solid solution), with traces of carbon monoxide, carbonic dioxide, nitrogen, and possibly argon.

A separation which is accurate enough for analytical purposes is made possible by heating the copper, first, in carbon dioxide, for absorbed gases; secondly, in hydrogen to take out the oxygen; thirdly, in carbonic acid for a short time to take out considerable residual hydrogen, which would be, otherwise, retained.

Copper absorbs and retains but traces of pure carbonic acid, so that gas will expel hydrogen under heat. The first and third propositions have, hitherto, been overlooked.

DIVISION OF FERTILIZER CHEMISTRY

Paul Rudnick, chairman

J. E. Breckenridge, secretary

PAUL RUDNICK (chairman's address): *Fertilizer Chemistry—A Report of Progress.*

The consumption of commercial fertilizers for the year 1910 is estimated, in round numbers, at about 5,750,000 tons, an increase of approximately 14 per cent. over that of 1909. The average annual increase in the past decade has been close to 11.3 per cent.

The cost of ammoniates which supply the nitrogen in fertilizers has materially advanced, as the demand is greater than the supply. Inorganic ammoniates, including nitrate of soda, sulphate of ammonia and the products made from atmospheric

nitrogen by chemical and electrochemical processes, are produced in constantly increasing quantities, but organic ammoniates, including tankage, blood, etc., can not be produced in sufficient quantity to meet the demand and can not be entirely replaced by the inorganic sources of nitrogen for reasons involving mechanical condition, so that the fertilizer may be applied to the soil by suitable machinery. Much care and thought should be given to methods of control by state fertilizer authorities, so that arbitrary methods of analysis may not prevent the utilization of organic ammoniates which are now being wasted and thus the cost of the necessary organic ammoniates be forced up beyond all reasonable bounds. This is a matter of conservation of resources as well. The nitrogen of practically all the coal burned in this country should be recovered in the form of sulphate of ammonia.

In striking contrast to the demand for high availability of nitrogen is the proposal to use raw phosphate rock, the phosphoric acid of which is admittedly not available or at least so slowly that its application does not pay. It is highly desirable that commercial methods of producing available phosphoric acid from phosphate rock by cheaper and more efficient means than by conversion into acid phosphate should be found, although the Wisconsin Agricultural Experiment Station has recently pointed out that the sulphur in acid phosphate, present as calcium sulphate and produced by the treatment of phosphate rock with sulphuric acid, is a very necessary element in fertilizers, as much as and in some cases more so, than phosphoric acid.

The German potash controversy has stimulated renewed activity in the search for sources of commercial potash salts in this country, so that we may not be dependent upon Germany for this important constituent. The U. S. Geological Survey is now engaged in drilling a well, at Fallon, Nevada, as it seems likely that such deposits may exist in that region.

After discussing the various theories proposed to explain the action of commercial fertilizers, the possibility is pointed out that the results obtained from the use of commercial fertilizers may in part be due to a protective action which they exercise on the cells of the plant in some way similar to the action of the salts in sea water on animal organisms.

The need of a comprehensive and scientifically accurate theory of fertilizers is pointed out, so that wasteful and unscientific use may give way

to the most efficient and economical, hence most profitable, use.

BURT L. HARTWELL and F. R. PEMBER: *The Effect of the "Wet Process" on the Availability of Low-grade Nitrogenous Materials.*

In all, two crops of Japanese millet, two of oats and one of buckwheat were grown in pots on two different soils which were supplied with all the necessary non-nitrogenous manures. The amount of nitrogen supplied in the various nitrogenous materials which were tested was the same for each crop. Hair tankage, garbage tankage and roasted leather were used both before and after being subjected to digestion in the presence of phosphate rock and sulfuric acid (the "wet process").

The nitrogen of the garbage tankage had a very low availability both before and after acidulation; while that in roasted leather and hair tankage, although of low availability before, was much more available after treatment.

The treatment by the "wet process" of these nitrogenous materials individually was conducted in the laboratory, but a mixture of the three was treated by the regular "wet process" in a fertilizer factory. Over 70 per cent. of the nitrogen in the "base goods" so manufactured was soluble in water and highly available, but the insoluble nitrogen was of no immediate value.

F. B. PORTER: *A Method for Testing Out Problems in Acid Phosphate Manufacture.*

1.1 grams rock dust are weighed into 5" × $\frac{1}{8}$ " test tube, known amount of acid added from Mohr's pipette. Stir three minutes, keep at any desired temperature for any desired time.

Transfer on to 9 cm. filter paper with water and determine insoluble phosphoric acid.

Average of three or four tests taken for result.

I. K. PHELPS: *Exact Work in Fertilizer Analysis.*
C. H. JONES: *Activity of Organic Nitrogen as Measured by the Alkaline Permanganate Method.*

The alkaline permanganate method for nitrogen activity is described in detail, together with the form now used for reporting results.

Results on fourteen different crude nitrogenous stock samples, 8 commercial fertilizers, and 13 mixtures of known composition are stated in tabular form, and explanations are given as to their interpretation from a standpoint of nitrogen activity.

A method is presented for determining the percentage of "nitrogen in the organic and volatile matter." Its application to fertilizers and crude stock as a means of determining whether the

organic nitrogen present came from materials rich or poor in that element is discussed.

H. G. BELL: *Fertilizer Economics*.

Advantages of mixed fertilizer are brought forth.

The fertilizer industry an essential factor in the business and life of the country.

European and American yields on wheat, oats, barley and potatoes are compared, showing Europe far ahead in crop yields.

North Atlantic states compared with middle Atlantic states shows gains for north Atlantic states in yield per acre due to rational use of mixed fertilizer.

Records of large gains by using fertilizer are given in Indiana and Ohio.

Sound economic principles as the basis of manufacture and sale of fertilizer are considered.

E. B. HART: *The Sulphur Requirements of Crops in Relation to the Soil and Air Supply*. (From the Laboratory of Agricultural Chemistry, University of Wisconsin.)

The average crop of cereal grains and straws removes about two thirds as much sulphur as phosphorus, mixed grasses remove the two in about equal proportions, while alfalfa removes about 60 per cent. more sulphur than phosphorus. Members of the Crucifere, such as cabbage and turnips, may remove two to three times as much sulphur as phosphorus.

The superior results often obtained in the case of acid phosphate as compared with other sources of phosphoric acid may not be due entirely to the solubility of the phosphoric acid, but also to the additional sulphur supplied by the acid phosphate in the form of calcium sulphate. The idea that sulphur may become a limiting element in crop production would further account for the beneficial results obtained from gypsum, sulphate of potash and other sources of sulphur commonly contained in fertilizers.

J. P. STREET: *Note on the Neutral Permanganate Method for Availability of Organic Nitrogen*.

The adding of one gram of sodium carbonate to the neutral permanganate solution just before adding material to be tested largely overcomes the loss in availability when high-grade ammoniates are mixed with large proportions of acid phosphate.

Results on many organic ammoniates in presence of acid phosphate are given, showing that the method does differentiate between high and low grade materials.

A. J. PATTON and C. S. ROBINSON: *Conductivity Method of Making Neutral Ammonium Citrate Solution*.

This method, worked out independently by the authors, is essentially the same as that proposed in the meantime by Hall and Bell¹ and later shown by Hall² to be quite suitable for ordinary laboratory use, and their results are fully confirmed by this work. In addition comparative determinations of insoluble phosphoric acid were made, using solutions neutralized by the conductivity method and by the indicator method. The data justified the conclusion that the conductivity method is much to be preferred in every way to the indicator method.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

H. P. TALBOT, *chairman*

S. L. BIGELOW, *secretary*

JAMES R. WITHEROW: *The Relative Densities of Sodium Amalgam and Mercury*.

R. B. MOORE: *The Formation of Helium from the Thorium Emanation*.

A. B. DAVIS, IVY MILLER and R. B. MOORE: *Nipponium*.

II. H. WILLARD: *The Quantitative Separation of Lithium from Sodium and Potassium*.

Sodium and potassium may be separated from lithium by precipitation as silicofluoride in methyl alcohol solution. Ethyl alcohol and acetone cause a large amount of lithium to be precipitated with the sodium and potassium. To the solution, which should be very small in volume—not over 10 c.c.—is added a little hydrochloric acid, then hydrofluosilicic acid, and 75 or 80 c.c. methyl alcohol. Several hours are required for complete precipitation. If the amount of lithium is large, the precipitate must be dissolved and reprecipitated. It may be dried at 150°–180°.

Lithium may be quantitatively precipitated from a neutral solution by means of tribasic tetramethyl-ammonium phosphate, methyl alcohol being added to make the precipitation more complete. If present in considerable amount, a little sodium is carried down, but a second precipitation will give a complete separation.

H. H. WILLARD: *The Preparation of Perchloric Acid*.

Ammonium perchlorate is oxidized by means of nitrohydrochloric acid, the ammonium being thus

¹ *Jour. of the Am. Chem. Soc.*, 33, p. 711, 1911.

² *Jour. of Ind. and Eng. Chem.*, 3, p. 559, 1911.

removed and perchloric acid remaining. The best proportions are: 1 kg. ammonium perchlorate, 800 c.c. water, 600 c.c. nitric acid (sp. gr. 1.42), 200 c.c. hydrochloric acid (sp. gr. 1.2). The hydrochloric acid is added slowly to the boiling solution of the other substances, using a reflux condenser. After about one hour the solution is evaporated until all nitric and hydrochloric acid is removed. The yield is the theoretical.

CHARLES H. WHITE: *A Colorimeter for Rapid Work with Widely Varying Standards.*

The standard and the unknown solution are compared in hollow wedge-shaped prisms of glass, placed vertically in a camera behind screens provided with a narrow horizontal opening opposite the eye for the simultaneous observation of the two solutions. The wedges are held in graduated carriers, by the vertical movement of which the thickness of the section of solution observed is varied. The wedge containing the unknown is set at the graduation representing the percentage of color-producing agent in the standard. The standard is then adjusted to match the color of the unknown and the percentage in the unknown is read directly.

IRVING LANGMUIR: *The Dissociation of Hydrogen into Atoms at High Temperatures.*

In a previous paper (to be published in the *Phys. Rev.*) it was shown that the laws of heat convection in gases are much simpler than has been generally supposed. In fact, the problem reduces to one of simple conduction through a film of relatively stationary gas held in place by viscosity. The thickness of the film in any gas under any given conditions may be calculated accurately by simple formulas. If the energy loss for a tungsten filament in hydrogen be calculated in this way the results agree with observed values within the experimental error up to a temperature of about 2300° K., but above this show rapidly increasing differences. At 3300° K. the observed energy loss is over four times the calculated. It is assumed that this difference is due to the dissociation of hydrogen molecules into atoms. The variation of the energy loss with the temperature and with the pressure agree quantitatively with this theory. Simple unforced theoretical considerations form the basis for a calculation of the heat of formation of hydrogen molecules and the percentage dissociation at various temperatures. The results are: Heat of formation of H_2 , 125,000 cal. Percentage dissociation (1 atmo.): at 2500° K. 3.9; 2700°, 10.0; 2900°, 22.1; 3100°, 40.4; 3300°,

61.4. In the case of the monatomic gas, Hg vapor, the calculated energy loss does not show differences with the observed values similar to the above.

IRVING LANGMUIR: *A Chemically Active Modification of Hydrogen.*

When a tungsten wire is heated to a temperature between 1300° and 2500° K. in hydrogen at very low pressure (0.001–0.020 mm.) the hydrogen slowly disappears. With nitrogen or carbon monoxide such disappearance never occurs below about 2200° K. and seems to be an electrical effect, while with hydrogen it is purely thermal. There is a distinct fatigue effect, but the substitution of a new section of wire does not restore the action. The hydrogen is not absorbed by the wire, but is deposited on the glass, especially where the latter is cooled by liquid air. If the wire is allowed to cool and the liquid air is then removed, ordinary hydrogen is set free which will not recondense when the liquid air is replaced. If this gas is pumped out and oxygen is admitted the oxygen will disappear and in its place a small quantity of hydrogen will appear. With platinum and especially with palladium wires these effects are much more marked. These effects are not due to the presence of finely divided metal on the surface of the glass. When phosphorus is present on the inner surface of the bulb and hydrogen is introduced and the wire heated to a temperature of about 1900° K., the hydrogen disappears and phosphine is formed (apparently the first direct synthesis of phosphine). These effects are accounted for by the theory that the hydrogen dissolves in the material of the wire in the atomic condition and that some of these atoms leaving the wire, do not meet other atoms (because of the low pressure) but diffuse into the tube cooled by liquid air, or become adsorbed by the glass, and thus remain in the atomic condition, retaining all of the chemical activity of the atoms.

IRVING LANGMUIR: *Melting Point of Tungsten.*

The melting point was determined by heating pure ductile tungsten wires in pure hydrogen to gradually increasing temperatures until the wire melted through. The temperature was found from the candle power emitted per square mm. of surface, using a modified form of Rasch's equation. The advantages of an atmosphere of hydrogen are: (1) Vaporized metal is carried away by the hydrogen and does not blacken the tube and interfere with candle-power measurements. (2) The energy loss from small wires in hydrogen is nearly independent of the diameter of the wire, therefore

if the wire becomes thin in one spot the tendency to burn out is much less than it would be with the wire run in vacuo. It is therefore possible to make reliable measurements of the candle power at a temperature much closer to the melting point than is possible in vacuo. The results were: in hydrogen 3250° K., 3345°, 3430° and one somewhat doubtful value of 3500°; in mercury vapor, 3450° K. and 3350°. As the method tends to give low results it is highly probable that the melting point of tungsten is at least 3500° K. or about 3250° C. This is in good agreement with the value given by Pirani 3300° C., but very different from that of von Wartenberg, who gave 2900° C. JOEL H. HILDEBRAND: *The Thermal Dissociation of Barium Peroxide.*

This equilibrium has been investigated on account, not only of its scientific interest, but because of its practical application in the manufacture of oxygen and hydrogen peroxide.

The nature of the phases involved was determined by observing the effect upon pressure of removing successive portions of oxygen, the temperature being kept constant. It was shown that within certain limits the oxide and peroxide form solid solutions in each other, and that a barium hydroxide phase must also be present. Conditions for reversing the equilibrium were stated.

Accurate measurements of the dissociation pressures of the univariant system were made, and the thermodynamics of the system discussed.

S. C. LIND: *Chemical Combination and Disintegration under the Influence of Radium.*

Chemical action produced by radium is due almost entirely to the α -rays. For gas reactions both of combination and of disintegration the number of molecules affected in a given time is of the same order of magnitude as the number of ions formed by the α -rays in that time, as calculated from Bragg's experiment on the ionization of gases. Data of Ramsay and of the author verify this conclusion with respect to radium emanation. A method is proposed for calculating simply the mean path of α -rays in cylindrical and spherical vessels. The principle found true for gases may also be extended to liquid systems, data of Ramsay, of Debiegne, and of the author being used for its establishment both for emanation and radium salt in solution.

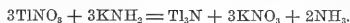
EUGENE C. BINGHAM: *Fluidity and Vapor Pressure.*

E. C. BINGHAM and G. F. WHITE: *Fluidity and Hydration.*

E. C. BINGHAM and G. F. WHITE: *A New Viscosity-meter.*

EDWARD C. FRANKLIN: *Potassium Ammonio Thallate.*

When the ammonio base, potassium amide, in solution in liquid ammonia is added to a solution of thallium nitrate in the same solvent a black precipitate of thallium nitride is formed in accordance with the equation,



Thallium nitride dissolves in a liquid ammonia solution of potassium amide to a clear yellow solution from which potassium ammonio thallate of the composition represented by the formula, $\text{TiNK}_2 \cdot 4\text{NH}_3$, may be obtained in the form of beautiful yellow crystals. The action of potassium amide on thallium nitride is represented by the equation,



WILLIAM BLUM: *The Hydrolysis of Sodium Oxalate and its Influence upon the Test for Neutrality.*

The testing of sodium oxalate for use as a primary standard in acidimetry and oxidimetry requires a knowledge of the normal alkalinity. Decimolar solutions of pure sodium oxalate were found to produce a pink color with phenolphthalein equivalent to 4 per cent. transformation of the indicator, instead of the calculated 8 per cent., showing discrepancies in the accepted constants or theories. Colorimetric comparisons were made with solutions calculated from Sørensen's E.M.F. measurements, indicating that for 0.1 *m* $\text{Na}_2\text{C}_2\text{O}_4$, $[\text{H}^+]_{18.0} = 2.5 \times 10^{-9}$; and that the salt is hydrolyzed to the extent of 0.0024 per cent. The error produced in a titration by neglecting this normal alkalinity is negligible.

R. C. WELLS: *The Fractional Precipitation of Hydroxides.*

By fractionally precipitating dilute solutions of various pairs of metallic salts with caustic soda the following series was obtained, such that the higher members are more precipitable: ferrium, aluminum copper, zinc, lead, nickel, silver, ferrosium, manganese, magnesium, calcium. The position of a metal in the series is probably determined by (1) the solubility of the hydroxide and (2) the extent of hydrolysis of the metallic salt. The series agrees well with the order of the heats of precipitation of the hydroxides.

C. W. EASLEY and B. F. BRANN: *The Atomic Weight of Mercury.*

By means of bringing an excess of pure bromine in contact with pure mercury at approximately 300°, mercuric bromide was sublimed into a convenient receiver, which in turn was heated almost to the point of sublimation of the material in a stream of nitrogen. On cooling, the nitrogen was displaced by dry air.

From this material, mercuric oxide was precipitated by the use of a slight excess over the calculated amount of sodium hydroxide. This action was brought about in a flask with well-guarded openings so that the subsequent reduction with hydrogen peroxide or with hydrazine gave rise to no loss of the solution in the form of spray. The solution being separated from the free mercury, the bromine was determined as silver bromide in the usual way. The value 200.63 was obtained as the result of eleven concordant determinations of the ratio $\text{HgBr}_2:2\text{AgBr}$, no determinations, of course, being rejected.

J. I. D. HINDS: *Precipitation of the Copper-Arsenic Group and the Separation of its Divisions.*

A definite acid concentration is secured. Arsenic is precipitated in 2 normal hydrochloric acid solution, the other metals in half normal hydrochloric acid solution. Tin is precipitated as stannic sulfid. The sulfids of arsenic, antimony and tin are dissolved in colorless ammonium sulfid, or in ammonium hydroxid and hydrogen sulfid.

To a portion of the solution add one ninth its volume of hydrochloric acid (making it normal in HCl since the laboratory acid is about 10 normal) and a few drops of nitric acid to oxidize stannous to stannic ion. Boil the mixture a little more than half away in an Erlenmeyer flask, making the residual liquid 2 normal, pass a rapid stream of hydrogen sulfid until precipitation is complete (5 to 10 minutes), add enough water to make the volume twice the original, making the solution one half normal in hydrochloric acid and continue to pass hydrogen sulfid until precipitation is complete (10 to 15 minutes). Filter and wash.

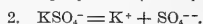
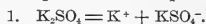
Transfer the precipitate to a beaker, cover it with ammonium hydroxid, pass hydrogen sulfid rapidly for a minute, warm, shake, filter and wash. The filtrate contains the thioanions of arsenic, antimony and tin; the residue contains the sulfids of the other metals of the group.

Treat filtrate and residue in the usual way.

Time required for the entire process 30 to 45 minutes.

WILLIAM D. HARKINS: *The Intermediate Ion Hypothesis.*

The values now used for the degrees of dissociation of univalent salts, such as K_2SO_4 , BaCl_2 , or $\text{Cu}(\text{NO}_3)_2$, do not represent the degrees of dissociation at all, but are only the values of the conductance ratio, if intermediate ions are present in the aqueous solutions of salts of this type. In recent papers¹ it has been shown that the solubility relations of such salts indicate that the ionization takes place in two steps as follows:



Potassium sulphate, according to the present values used, is 71 per cent. dissociated in its tenth normal solution at 25°. Approximate calculations made upon the basis of the intermediate ion hypothesis indicate that its actual *total* dissociation is about 95 per cent.

It seems probable that *all triionic salts, acids and bases, when dissolved in water, dissociate in two steps, and that intermediate ions are present in all such solutions.* If this is the case, it seems self-evident that intermediate ions must be present in *all* aqueous solutions containing salts, acids or bases of still higher types. The percentage of the salt present as the intermediate ion is zero at zero concentration and increases as the concentration of the salt in the solution increases.

The constant $k = (\text{K}^+ \times \text{KSO}_4^- / \text{K}_2\text{SO}_4)$ increases with the total ion concentration and is several times larger, in the case of salts, than the second constant $k = (\text{K}^+ \times \text{SO}_4^{--} / \text{KSO}_4^-)$.

Solutions of certain salts, such as lead chloride, contain an abnormally large percentage of the intermediate ion.

G. R. WHITE and H. EASTWOOD: *Electrolytic Corrosion in Ammonium Salts.*

Test pieces of copper, nickel, zinc, tin, iron and cadmium were made anodes in solution of ammonium chloride, sulphate, nitrate, acetate and tartrate containing 75 g. of the salt per liter. The anodes were rotated to ensure thorough stirring. The electrolysis was carried on at room temperature for an hour with a current of .35 amp. The average current density was 2.8 amp. per sq. dm. The results, which are given as percentage efficiency of corrosion, show that corrosion is markedly different for different electrolytes and that it is affected by changing the current density and in some cases by changing the temperature.

J. W. TURRENTINE and RAYMOND L. MOORE: *Contributions to the Electrochemistry of Hydro-*

¹ *Jour. Am. Chem. Soc.*, 33, pp. 1807-73.

nitric Acid and its Salts. II. The Action of Copper and of Cuprous Oxide on Hydronitric Acid.

In order to test the plausibility of certain reactions proposed to account for the phenomena observed at magnesium, aluminium and zinc anodes in sodium trinitride solution, reactions analogous to those hypothesized were induced and the accompanying phenomena were examined. The action of cuprous oxide on hydronitric acid is that of a reducing agent, the acid being reduced to ammonia and free nitrogen and the cuprous oxide becoming cupric trinitride. The relations here existing may be represented qualitatively by the expression: $\text{Cu}_2\text{O} + 5\text{HN}_3 = 2\text{CuN}_3 + \text{H}_2\text{O} + \text{NH}_3 + \text{N}_2$. With metallic copper, cupric trinitride results, and ammonia and gaseous nitrogen again appear as the reduction products. To represent this reaction, the equation is given:



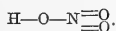
J. W. TURRENTINE and LEONARD A. MAYNARD:

The Reduction of Hydronitric Acid by Cadmium.

Hydronitric acid dissolves cadmium with effervescence. A neutral solution of cadmium trinitride and ammonium trinitride results. The gas evolved is nitrogen. The following equation is proposed to represent the course of the reaction:



The products of the reaction have been measured. In the reactions with cuprous oxide, copper and cadmium (and with numerous other substances), hydronitric acid is found to be an oxidizing agent, an analogue of nitric acid, a fact which leads to an analogous structure. Accordingly, the structural formula for hydronitric acid, $\text{H}-\text{N}=\text{N}=\text{N}$, is proposed, analogous to that of nitric acid,



This structure is supported by numerous reactions and considerations yet to be presented. Just as nitric acid is regarded as a hydrated oxide of nitrogen, hydronitric acid may be considered an ammoniated nitride of nitrogen.

E. H. ARCHIBALD: *The Hydrolysis of Potassium Chloroplatinate.*

The hydrolytic decomposition of solutions of potassium chloroplatinate at a temperature of 25° has been studied. The hydrolysis can be followed by titrating the hydrochloric acid formed with sodium hydroxide, using phenolphthalein as indicator.

The hydrolysis takes place very rapidly under the influence of light, apparently the ultra-violet rays only being concerned, as no action is caused by the strongest illumination from four Welsbach mantles. In bright sunlight at a temperature of 25° the reaction is complete in the case of a N/50 solution in 200 minutes when an amount of hydrochloric acid will have been formed equivalent to 36.5 per cent. of the chlorine present as platinum tetrachloride. A solution of this strength prepared in non-actinic light and kept in the dark has not attained equilibrium before several weeks. In the case of a hundredth normal solution the time required for equilibrium to be established in bright sunlight is 175 minutes and hydrochloric acid is formed corresponding to 50 per cent. of the chlorine present as platinum tetrachloride.

The reaction reverses to a small extent when the solution hydrolyzed by the bright sunlight is placed in the dark.

The reaction reverses much further, rapidly in the light but very slowly in the dark, when potassium chloride is added to the hydrolyzed solution.

E. H. ARCHIBALD and E. F. CONWAY: *The Hydrolysis of Potassium Bromoplatinate.*

The hydrolysis of potassium bromoplatinate has been studied after the manner of the previous investigation. The source of the ultra-violet rays was in this case an electric arc placed about 25 cm. from the solution to be studied. The temperature was kept constant at 25°. The hydrolysis is more complete than in the case of the chloroplatinate; the amount of hydrobromic acid formed in a N/100 solution corresponded to 78 per cent. of the bromine present as platinum tetrabromide. The reverse reaction also goes further when the hydrolyzed solution is placed in the dark.

A solution of the bromoplatinate prepared in the absence of actinic rays and kept in the dark showed no detectable hydrolysis after five days.

H. C. COOPER, E. H. KRAUS and A. A. KLEIN: *Lead Silicates.*

Having subjected the system $\text{PbO}-\text{SiO}_2$ to thermal analysis and optical analysis, the latter particularly difficult because the refractive indices of most of the lead compounds are higher than the index of any known immersion liquid, the authors conclude that PbSiO_3 , Pb_2SiO_4 and $\text{Pb}_3\text{Si}_2\text{O}_7$ are well-defined compounds and that Pb_2SiO_4 is probably also an independent substance. The minerals barysilite, found in Sweden by Sjögren and Lundström and the mineral alamosite, recently described independently by Palache, correspond fully

with the compounds $Pb_3Si_2O_7$ and $PbSiO_3$, respectively. It is interesting that the artificial alamosite was prepared and characterized before its counterpart was found in nature. The crystallized lead silicate formations found under dismantled smelters are rather miscellaneous in character, the largest crystals being of mixed composition.

H. S. FRY: *Some Application of the Electronic Conception of Positive and Negative Valencies: V. Dynamic Formulæ and Absorption Spectra of Chlor- and Brom-benzenes.*

F. D. WILSON: *A Further Study of the Action of Calcium Carbonate on Zinc Sulphate Solutions.*

When calcium carbonate and zinc sulphate solutions are brought into contact with one another in varying preparations, and at different temperatures, and for different periods of time, the basic carbonate is formed.

When the solution of zinc sulphate is changed into carbon dioxide, and calcium carbonate added, and carbon dioxide passed in for several days, the normal carbonate of zinc with from 0.8 to 1.5 per cent. of water is formed.

ROBERT B. SOSMAN: *The Nitrogen Scale from 300 to 600 Degrees.*

CHARLES BASKERVILLE and ABRAHAM LUSSKIN: *Chemical Tests for Lanthanum.*

As far as we are aware, there are no chemical tests for lanthanum which are so distinctly characteristic as to be used to prove the presence of that element when associated in mixtures with neodymium or praseodymium. Recourse must be had to photographic reproduction of the arc or spark spectrum, facilities for which do not constitute a part of the armamentarium of all analytical chemists, and at best this is not applicable upon a quantitatively qualitative basis.

Having exhausted the probabilities of analogous tests for other metals, recourse was had to the empiricism offered by a Kahlbaum catalogue. While much not recorded in the literature was observed as to the conduct of this subgroup of the so-called rare earths with many unusual reagents, the main object was to secure some one or more definitely distinctive tests for lanthanum alone or in mixtures. While it may be stated that results altogether satisfactory were not obtained, the following may be noted.

Conduct with Sodium Potassium Tartrate.—Solutions of lanthanum, neodymium and praseodymium salts, singly or mixed with each other,

give precipitates with this reagent which dissolve in an excess of the precipitant. On adding oxalic acid to these solutions a precipitate is produced in each case, but with lanthanum the precipitate is soluble in excess. Filtration, evaporation and ignition yield lanthanum oxide. The delicacy of the reaction and all the determining factors have not been established.

Conduct with Cyanates.—Potassium cyanate gives a white gelatinous precipitate insoluble in excess. On standing the precipitate changes into beautiful silk-white crystals. Similar conduct was observed with neodymium and praseodymium salts, except that each of the latter exhibited the characteristic rose or light green tint. The solubility of these cyanates, the composition of which has not been determined, was investigated, using a great variety of solvents, some very unusual. A difference was noted in the solubility in bromine water, the lanthanum salt being more soluble. In acetic acid, however, the lanthanum salt dissolved much more slowly. The same was noted with lactic and phthalic acids and boiling sodium tartrate solutions. In the last the neodymium preparation is entirely soluble, whereas the lanthanum salt is only slightly, but appreciably, soluble.

Neither of the methods has so far shown itself suitable either for satisfactory qualitative purposes or for separating lanthanum from the didymium on a laboratory scale.

Suggestions as to rarely applied tests will be most acceptable.

CHARLES BASKERVILLE: *On the Simplicity of Praseodymium.*

The results of twelve years' study of praseodymium with different assisting workers in an effort to show its complexity are given. All efforts to decompose praseodymium were unsuccessful. The investigations were carried out along the following lines: (1) fractional precipitation from salt solutions; (2) fractional solution of the black oxide in acids; (3) fractional decomposition of the nitrate by heat; (4) fractional crystallization of double nitrates, one being an isomorphous nitrate of another metal; (5) fractional oxidation of a soluble salt of praseodymium; (6) fractional oxidation of the oxide by fusion with an alkali peroxide, and (7) fractional electrolysis, with and without a porous cell. The absorption spectrum of the different fractions, several thousand all told, was taken as a criterion as to any disintegration. Solutions of a definite strength, acidity and thickness were compared.

J. E. MILLS: *Force*.

Elasticity is a property very similar to temperature, depending upon the motion of certain parts of larger elastic bodies. When these fundamental particles collide they simply exchange velocities instantaneously. Neither motion nor energy is for a fraction of a second lost.

The usual definition of force is: "A unit force is that force which, acting on a mass of one gram for one second, will give to it a velocity of one centimeter per second." In a medium when the particles exchange their velocities instantaneously this definition of force does not apply, as the words "for one second" have no meaning. More important is the fact that the kinetic energy of a moving body must then be measured by its mass (probably amount of matter) times its velocity, instead of by one half its mass times the square of its velocity.

The term "attractive force" has been applied to chemical, molecular, gravitational, electrical and magnetic attractions. Some in consequence of our definition of force have invested these phenomena with attributes which they do not possess.

W. E. HENDERSON: *A Jacket for a Victor Meyer Apparatus*.

The usual form of glass jacket is replaced by a beaker deep enough to contain the bulb of the inner tube. The beaker is covered with a copper sheet in the center of which is a circular hole large enough for the insertion of the bulb. Concentric with this hole is a deep groove in the cover in which the square end of a piece of large glass tubing rests in a water seal (a broken outer jacket cut square will serve). The beaker should have no lip.

W. E. HENDERSON and H. B. WEISER: *The Action of Sulphurous Acid upon the Sulphides of Iron and Manganese*.

When freshly prepared sulphides of iron or manganese are treated with sulphurous acid the primary action appears to be the production of the metallic sulphites and hydrosulphuric acid. The sulphites are held in solution as acid salts, and are precipitated as normal salts on warming the solution. The interaction of sulphur dioxide and hydrosulphuric acid produces free sulphur which converts a portion of the sulphites into thiosulphates. These have been isolated in pure form. Contrary to the statements in the literature, there is no dithionate or tetrathionate formed beyond possibly a mere trace.

R. F. BRUNEL: *The Equilibrium between Iso and Tertiary Butyl Bromides*.

CHAS. T. P. FENNEL: *A Strange Substance in Iodine*.

A. S. McDANIEL: *Chemistry of the Silver Volt-ammeter*.

CHAS. A. KRAUS and WM. C. BRAY: *A General Law of Ionization of Binary Electrolytes*. (Presented by Wm. C. Bray.)

From a preliminary examination of the existing conductance data in various solvents the first named author four years ago suggested the relation

$$\frac{(C\gamma)^2}{C(1-\gamma)} = K + D(C\gamma)^m,$$

where C is the concentration, γ the degree of ionization calculated from the conductance ratio Λ/Λ_0 , and K , D , m are constants. A more careful study, which is still in progress, has furnished striking confirmations of this law. The evidence that the law of mass action is obeyed in dilute solutions is based on the experimental results of Franklin and Kraus in liquid ammonia and of Dutoit and his coworkers in propyl, butyl and amylalcohols and in acetone, sulfur dioxide, pyridine, etc. There is a rough parallelism between the values of K for a typical salt (as NaI) and the dielectric constants of the pure solvents. The deviations from the law of mass action are in general appreciable when the ion concentration is greater than 0.0005 normal. The values of m usually lie between 0.4 and 0.6 in aqueous solution and between 0.9 and 1.2 in liquid ammonia and are still larger in solvents of lower dielectric constants. Whenever m is greater than 1, the values of the equivalent conductance pass through a minimum as the concentration increases and then increase with increasing concentration. D is the controlling factor in determining γ at high ion concentration, and usually lies between 0.1 and 5.0 for the different solvents. The above law ceases to hold in the neighborhood of normal concentration, and Λ then decreases with increasing concentration. There is evidence that this decrease is connected with the rapidly increasing viscosity of these concentrated solutions.

HARRY N. HOLMES: *The Detection of Ozone*.

The paper presented the various theories explaining the presence of ozone in nature and gave the results of six months' ozone tests in outdoor air. In June and July the quickest response to a starch potassium-iodide test was an hour and a

quarter, except in the case of a thunder-storm, when the record was set at fifteen minutes. In the hottest days of July no test at all could be obtained and none at night in either month. This would seem to indicate that the ultra-violet rays of sunlight have a great deal to do with the formation of ozone.

In the bracing days of late November the weather was cold and snappy. A test resulted in less than twenty-five minutes on November 13. During the following three weeks several tests were secured in thirty or forty minutes. At this time the silent electric discharge between earth and clouds must have been quite instrumental in forming the ozone. The greater stability of ozone in cold weather allowed it to accumulate.

Probably after a cyclonic disturbance of the upper air we on the surface get a supply of ozone manufactured in the upper laboratories. On the occasion of some of the above tests air was drawn over crystals of chromic acid to eliminate the effect of hydrogen peroxide. Furthermore, delicate reagents for hydrogen peroxide and nitrites failed to yield a test. The inference is that all the above tests were due to ozone alone.

JAMES M. BELL and MELVILLE L. BUCKLEY: *The Solubility of Bromine and Iodine in Aqueous Solutions of Alkali Bromides and Iodides.*

C. W. FOULK: *A Modified Burette Calibrating Pipette.*

W. M. BLANCHARD: *A Simple Lecture Apparatus for Illustrating the Relative Ionizations of Salts.*

ARTHUR B. LAMB and JOHN W. MARDEN: *The Quantitative Determination of Perchlorates.*

The determination of perchlorates by fusion has, in spite of its great simplicity, been generally abandoned in favor of some method of reduction in solution. This has been due to the fact that during ignition or fusion there have been small but apparently unavoidable mechanical losses, presumably of potassium chloride. The authors have shown that by merely carrying on the fusion in a test tube, suitably plugged with asbestos wool, instead of in a crucible, these losses could be prevented, and by precipitation of the chloride as silver chloride a very simple but accurate determination of the perchlorate obtained.

G. N. LEWIS and F. G. KEYES: *The Potential of the Potassium Electrode.*

G. N. LEWIS and PAUL FARRAGHER: *Potentials between Liquids.*

J. E. SIEBEL: *The Molecular and Intermolecular Energy.*

In this paper the author attempts to show that, " PxV " being practically equal to " RxT " for permanent gases, no notable portion of the kinetic energy can be present therein as rotary or intermolecular motion, since neither of these motions could contribute to the pressure and volume energy, of which a full equivalent appears for every amount of heat or kinetic energy imparted to a gas, and that therefore all kinetic or heat energy of gases must be almost exclusively due to the translatory motions of the molecules, while other internal molecular motions must be confined to chemical, radiant and other energies. Confirmation of this the author also finds that the translatory molecular velocity in gases calculated on above basis, after different independent methods, is uniformly almost exactly double that of the velocity of sound in the respective gases, thereby indicating another mode of propagation of sound in addition to that by aerial resonance, in which new mode of propagation the molecular vibrations act as vehicle for the sound impulses, which new mode of propagation would fully explain all acoustic phenomena, including also such (audibility of very feeble sounds for miles, etc.) not explainable by aerial resonance only.

A. A. NOYES: *A Proposed System of Notation of Physico-chemical Quantities.*

JOHN JOHNSTON: *A New Form of Mechanical Vacuum Pump.*

This pump—known as the May Nelson Rotary Pump—consists essentially of two plates of metal, one fixed, the other movable; no valve, packing or fluid is required, though a little lubrication is desirable for mechanical reasons. A somewhat defective pump of this type has given a vacuum of 0.01 mm. when connected to the gauge by rubber tubing. It has exhausted 6 liters to 0.1 mm. in 2 minutes. After pouring in 1 c.c. of water, the pressure was reduced to 0.5 mm. in 4 minutes, without drawing any air through the pump. The exact mode of working is difficult to show without a diagram, but the principle may perhaps be made sufficiently clear by what follows:

In each of the metal plates are cut a series of concentric grooves, which are so situated that the projections on each plate will lie in the grooves on the other plate. Through the center of the fixed plate passes a shaft, on which is an eccentric carrying the movable plate. Rotation of the shaft thus produces an eccentric motion—but no rotation—of the movable plate; as a result there is,

between each adjacent pair of curved surfaces, a rolling contact which sweeps out the air ahead of it. The pump above mentioned has an inner diameter of 13 cm., a depth of 4 cm., and consists of three rings which pump in series; the speed of rotation of the shaft was 800 r. per minute; $\frac{1}{4}$ H.P. suffices to operate it.

The effectiveness of this form of pump appears to be due to two things: (1) A very slight travel of the metal parts produces a relatively rapid motion of the crescent-shaped spaces between the rings on the two plates; (2) the contacts, since they occur between curved surfaces of nearly the same radius, are relatively long; hence the viscosity of the air is sufficient to prevent appreciable leakage backwards.

This pump may also be operated as a blower, or, with slight modifications, can be used as a water motor; indeed, since the rings may be made independent of one another, one can drive the pump by supplying water to one ring and obtain vacuum or blast from the other rings.

SECTION OF INDIA RUBBER CHEMISTRY

D. A. Cutler, *chairman*

F. J. Maywald, *secretary*

W. A. DUCCA: *Testing Methods of Rubber Contents in Raw and Vulcanized Rubber.*

The paper deals with modern methods of rubber analysis by nitrosate and tetrabromide methods. Mostly a historical review of the work done along these lines. In accordance with his own experiences the author concludes that the nitrosate method is not suitable for the determination of rubber in either raw or vulcanized samples, but yields apparently satisfactory results for sulfur of vulcanization. Budde's tetrabromide method gives a fair idea of the percentage of actual rubber in samples of raw material, but is not applicable for vulcanized goods. Huebner's method, bromination under water, based on the Weber-Ditmar theory of vulcanization, is very unreliable in its present form. Until now only a way has been opened towards the development of methods to determine rubber directly.

S. P. THACHER: *On Mineral Compounds Used in Rubber.*

VICTOR HANZLIK: *A Few Notes on Rubber Goods Used in Beet Sugar Factories.*

FRANCIS R. PEABODY: *The Treatment of Crude Rubbers.*

DAVID BLOOM: *Does the Acidity of Crude Rubber Resin Indicate Its Botanical Origin?*

Rubber resins obtained by extraction with acetone, carefully dried and redissolved in warm alcohol, were titrated with standard alkali. The acidity of the resin (expressed as the number of cubic centimeters of alkali used) is referred to a standard quantity of the resin (one hundred milligrams) and this ratio is called the "acidity number."

In the course of the analyses of about one hundred and fifty varied samples of washed and unwashed crude rubbers, the acidity numbers of the resins seem to be a constant for all rubbers of the same class, regardless of their age or mechanical treatment.

CHARLES FOX: *Apocynum Rubber.*

CHARLES KNIGHT (chairman): *Report of Committee on Rubber Analysis.*

CHARLES L. PARSONS,
Secretary

SOCIETIES AND ACADEMIES

THE CHICAGO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-ninth regular meeting of the Chicago Section of the American Mathematical Society was held at the University of Chicago on Friday and Saturday, December 29-30, 1911, extending through three half-day sessions. The total attendance was fifty-seven, including forty-three members of the society.

Professor L. E. Dickson, chairman of the section, presided at the opening session on Friday morning. Professor E. B. Van Vleck presided at the session on Friday afternoon while Professor Dickson was delivering his address on the "History of the representation of numbers as the sum of squares," and Professor E. J. Townsend presided at the session on Saturday morning.

At the business meeting on Saturday morning the following officers of the section for the year 1912 were elected: Professor D. R. Curtiss, chairman; H. E. Slaught, secretary, and A. L. Underhill, third member of the program committee.

On Friday noon the members lunched together at the Quadrangle Club, and in the evening they dined together at the same place and spent one of the most enjoyable social occasions in the history of the section.

The following papers were read at this meeting:

Professor Arnold Emch: "Involutoric circular transformations as a particular case of the Steinerian transformation and their invariant net of cubics."

Dr. R. E. Root: "Iterated limits in general analysis."

Dr. Arnold Dresden: "Reduction of systems of linear differential equations of any order."

Dr. Louis Ingold: "Displacements in a function space."

Professor L. E. Dickson: "History of the representation of numbers as the sum of squares."

Professor F. R. Moulton: "Relations of families of periodic orbits in the restricted problem of three bodies."

Professor L. E. Dickson: "Note on Waring's theorem."

Professor L. E. Dickson: "Uniqueness of division in Cayley's algebras with eight units."

Professor J. B. Shaw: "On differential invariants."

Professor E. J. Wilczynski: "On some geometric questions connected with the problem of three bodies."

Professor Peter Field: "On Coulomb's laws of friction."

Dr. E. G. Bill: "Analytic curves in non-euclidean space."

Mr. H. F. Vandiver: "Theory of finite algebras."

Dr. Arnold Dresden: "Note on the second variation; Jacobi's equation and Jacobi's theorem in the calculus of variations."

Professor G. A. Miller: "Gauss's lemma and some related group theory."

Professor R. D. Carmichael: "On a class of linear functional equations."

Professor R. D. Carmichael: "On the theory of the gamma function."

Mr. Vandiver's paper was communicated to the society through Professor Dickson. In the absence of the authors, the papers of Mr. Vandiver, Dr. Bill, Professor Miller and Professor Carmichael were read by title.

The next meeting of the Chicago Section will be held at the University of Chicago, on Friday and Saturday, April 5 and 6, 1912.

H. E. SLAUGHT,
Secretary of the Section

THE BOTANICAL SOCIETY OF WASHINGTON

THE 78th regular meeting of the society was held at the Cosmos Club, Tuesday, February 6, 1912, at 8:00 P.M. President W. A. Orton presided. Thirty-seven members were present. Dr. H. W. Wollenweber and W. W. Ashe were elected to membership.

The following papers were read:

Conditions Favorable to Septoria lycopersici Speg.: J. B. S. NORTON.

The author reported on a series of observations made on the development of *Septoria* under various conditions affecting growth.

The Relation of Soil Acidity to Plant Societies: A. W. SAMPSON.

Since the day of Unger and Thurmann there has been considerable difference of opinion as to the relationship between soil chemistry and cover. The fact, however, that different soils support different plants is a matter of common observation. The bearing of soil acidity upon this point has been investigated by the author—chiefly in connection with range revegetation studies conducted in the Wallowa Mountains of northeastern Oregon.

The *Leguminosae* are commonly extremely sensitive to acid soils while many ericaceous species are rather closely confined to acid soils. For example, *Trifolium repens* fails in soils requiring for neutralization the relatively small amount, locally, of 5,000 pounds of lime per acre foot, while no species of *Vaccinium* is known that can be grown successfully in neutral or alkaline soils. Again, some genera (*e. g.*, *Populus* and *Rosa*) are apparently indifferent as regards soil preferences. The preeminent forage plant of the Wallowa Mountains, *Festuca viridula*, varies very widely in adaptability to acidity. The soils on which it grows luxuriantly vary in lime requirements from 5,000 to 41,000 pounds per acre foot. The four species of *Poa* and the two species of *Agropyron* occurring locally reach their best development on calcareous and neutral soils.

Notes of Travel in Central America: Professor A. S. HITCHCOCK.

Having visited the Canal Zone as members of the Smithsonian Biological Survey, Mr. Hitchcock and his son made a two months' side trip to Central America. Collections were made in Costa Rica at Port Limon, San José and Puntarenas, in Nicaragua at San Juan del Sur, Corinto, Masaya and Jinotepe, in Honduras at Amapala, in Salvador at La Union, Acajutla, Santa Ana and San Salvador, in Guatemala at Guatemala City, Volcanso Agua and Port Barrios. Mr. Hitchcock presented notes on the various incidents connected with travel in the countries mentioned and reviewed briefly the botanical results of the journey.

W. W. STOCKBERGER,
Corresponding Secretary

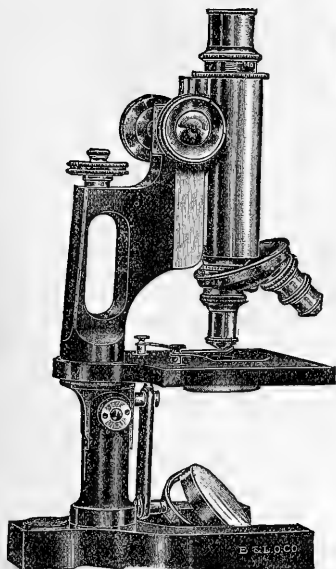
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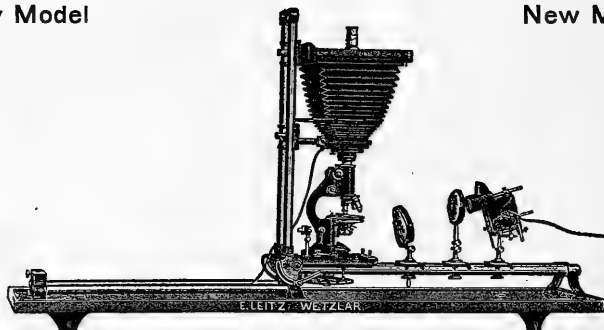
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INVESTIGATIONS OF THE CARNEGIE INSTITUTION¹

THE past fiscal year has been, on the whole, the most fruitful year on record for the ten specially organized departments of research in the institution. Although some of these are not yet fully equipped, they are all so well organized and provided for that their energies may now be chiefly directed to the attainment of definite results.

A development of much interest in connection with these departments is that of cooperative effort coming through research associates and collaborators. The departmental facilities are already in considerable demand from capable investigators, and many of them are found desirous of using these facilities, not only to forward their own researches, but to collaborate in the researches proper of the departments. The favorable experience which has accrued in recent years in these matters indicates that it may be advantageous in the future to seek to secure an additional number of investigators who, by reason of their eminence, may collaborate effectively in this manner.

Each of these departments has now under way such a variety and complexity of work that it is difficult to summarize. Reference must be made, therefore, for matters of detail, to the reports of the directors of the departments, published in full in the current year book. Hence such allusions in the following paragraphs as are made to the progress of the year are necessarily brief and can deal only with the more salient

¹From the Report of the President, Dr. R. S. Woodward, for the year 1911.

aspects of departmental affairs and researches.

DEPARTMENT OF BOTANICAL RESEARCH

The activities of this department now necessarily cover a wide range, since any successful attempt to solve the problems of the origin, development, migration, and modification under varying climatic conditions of plant life must require extensive field observations, much laboratory experimentation, and increasing application of the sciences of chemistry and physics. It is natural and proper, therefore, that the staff and collaborators of the department should include many specialists, and that they should approach the problems to be investigated from many points of view. Thus it happens that the investigations of the past year have embraced, among others, studies of the evaporation, the increasing salinity, and the changes in vegetation following close after the receding shores of the Salton Sea; of the influences of temperature, rainfall, sunlight, soil-moisture, etc., on plant organisms; of the effects following transplantation from low to high altitudes and from arid to humid localities; of the variations in water and acid content of plants; of the chemical effects induced in plant tissue by light and heat; and of the physiological functions of leaves in plant life.

One of the most interesting investigations under way during the year is that of Dr. Ellsworth Huntington, research associate of the department, on the secular variations of climate of the southwest desert area in recent geologic time. From this work it is believed that some of the salient fluctuations in climate during the past two or three thousand years may be clearly made out. Another noteworthy investigation of the year is that of the respiration of cacti, undertaken by Professor H. M. Richards in

collaboration with the department. This has developed the remarkable fact of a definite diurnal periodicity in the acid content of the sap of the cacti under observation. The progress and status of many other instructive investigations are set forth at length under the twenty subdivisions of the director's report, to be found in full in the current year book. From this it appears that, in addition to the regular and associate members of the staff of the department, about an equal number of individual investigators have collaborated in the researches under way. Special attention may be here invited to the detailed account given in one of the subdivisions of this report by Professor Tower in reference to his further experiments on the evolution of chrysomelid beetles, the results of his early work in this line under the auspices of the institution having been issued as publication No. 48.

DEPARTMENT OF EXPERIMENTAL EVOLUTION

It is a well-known fact that important generalizations in science usually leave a multitude of details to be worked out. Indeed, advances often raise more questions than they settle. Such has been the wonderfully fruitful effect of the doctrine of evolution propounded by Darwin, Spencer, and Wallace a half century ago. It should not be surprising, therefore, that the program of the Department of Experimental Evolution presents a considerable variety of investigations related to the highly complex problem of heredity chosen by the director as the principal object of research. Thus the work of the year includes investigations of heredity in plants, insects, birds, animals, and man.

One of the most promising investigations of the year is that of the director in reference to the heredity of epileptics. Through his connection with the Eugenics Record Office, he has collaborated with Dr. David

F. Weeks, of the New Jersey State Village of Epileptics, and secured a large quantity of accurate statistical data bearing directly on this disorder. From these data it appears not improbable that important practical deductions may be presently, if not already, drawn. Another investigation continued during the year, which involves prime utilitarian application, is that of Dr. Shull on the effects of self-fertilization in maize, or Indian corn. His earlier conclusions, published in 1908, have been confirmed by the later studies. A striking result from the latter is that, other conditions being the same, the yield of cross-fertilized plants proved fifty per cent. greater than that of the self-fertilized plants. Observational and experimental work has been carried on also along many other lines. The total number of zoological individuals under study exceeded 2,000, while the range of plants observed included nearly 500 species and upwards of 40,000 individuals.

DEPARTMENT OF ECONOMICS AND SOCIOLOGY

The diversified work of this department has proceeded during the year in accordance with the plan approved by the executive committee in May, 1910, which contemplated completing the researches then under way as well as might prove practicable under the limitations of the balance of appropriations previously made to the department. A full statement of these appropriations, of the expenditures under them to date, and of the present available balance, will be found in the section of this report devoted to the proposed budget for the ensuing year.

As explained at length by the chairman of the department in his report, to be found in the current year book, progress in the work under way is necessarily slow, since

the heads of the divisions of research and most of their collaborators are primarily engaged in other occupations. But in spite of this handicap, inherent in the organization, much work has been accomplished, and the chairman reports that several of the heads of divisions are now engaged on their final reports.

DEPARTMENT OF HISTORICAL RESEARCH

The eighth annual report of this department, and the sixth of the present director, is an instructive record of effective progress along all lines of work thus far undertaken to discover and to render available the sources of American history. Members of the department have been engaged during the year searching the archives of Great Britain, France, Spain, and Mexico, as well as those of the United States, for all accessible data, and these are being rapidly put in form for publication in convenient manuals. Three such works have been published by the institution during the past year, namely, "Guide to the Materials for American History in Roman and other Italian Archives"; "Inventory of Unpublished Material for American Religious History in Protestant Church Archives and other Repositories"; and "Calendar of Papers in Washington Archives relating to the Territories of the United States." The following are now in press: "Guide to the Manuscript Material relating to American History in the German State Archives" and "Guide to Materials for the History of the United States in the Principal Archives of Mexico."

It is worthy of remark that the results of this department's activities have received very general commendation from professional historians in Europe as well as in America. The ten manuals thus far issued are already much in demand in foreign countries, and they seem destined to become

as important in aggregate usefulness abroad as at home. It is hoped that the institution may be thus enabled to render adequate acknowledgment for numerous courtesies extended to the department by officials of governments, archives, libraries, and other establishments.

GEOPHYSICAL LABORATORY

The signal success already attained by this laboratory leaves no reason for doubt as to the practicability of continued advances toward solution of that large and difficult group of chemical and physical problems presented by the materials of the earth's crust. The current report of the director reviews twenty-six papers which have been issued by members of the staff of the laboratory during the year. Among these papers is a noteworthy contribution to general physics, in which the scale of precise thermometry is extended by 1250° C. This extension was an essential incident to the studies of mineral fusion, crystallization, etc., carried on in the laboratory, but it is of equal importance to other branches of physical research. Another noteworthy paper is a preliminary contribution to the long-standing question of the constitution of Portland cement. The complexity of this substance proves to be far greater than hitherto supposed; but its general characteristics have been determined and the resources of the laboratory are adequate to complete the remaining quantitative details of the investigation.

International appreciation of the work of the institution is now shown in many ways. The merits of the researches of the geophysical laboratory have been more promptly recognized, indeed, than its projects anticipated. Thus nearly all of the preliminary papers issued by members of the staff of the laboratory have been published in German as well as in English,

and arrangements have been made during the past year to have all such papers appear contemporaneously in both of these languages.

Of numerous investigations under way at the laboratory, attention may be called here to some preliminary studies of an active volcano, which indicate that the phenomena of vulcanism are within range of practicable determination and that progress in this direction is only a question of time and adequate effort.

DEPARTMENT OF MARINE BIOLOGY

In addition to the research work proper carried on by the director of this department during the year, much of his time and attention have been devoted to the construction of a new vessel and to the reconstruction of the laboratory at Dry Tortugas. Reference to this vessel, named the *Anton Dohrn*, has been made in a previous section of this report, and a description of her characteristics and equipment will be found in the current report of the director. It may suffice here, therefore, to state that this adjunct gives the department independent and adequate transportation facilities and greatly enlarged opportunities for marine research.

Mention was made in my report of a year ago of the probable damage done to the Tortugas laboratory by the destructive hurricane which swept the Florida Keys October 17, 1910. An inventory of the wreckage was made as soon as practicable, and it was found that an expenditure of \$4,000 would be essential to renew the establishment in a safe and effective manner. Accordingly, an allotment of this amount from the insurance fund of the institution was made by the executive committee at its meeting of November 17, 1910, and the wrecked buildings have been replaced during the past summer by struc-

tures at once more secure and more commodious.

On account of lack of quarters the director has been able to afford facilities for research at the laboratory to only eight investigators. Nevertheless, the year has proved fruitful in important advances. One of these, attained by Mr. G. H. Drew, of Cambridge University, relates to the rôle of certain bacteria in depriving surface sea water of nitrogen and in precipitating the vast deposits of chalky mud (oolite) of the Florida-Bahama region; another, by Dr. T. W. Vaughan, records definite progress in his quantitative determinations of the growth of corals and coral reefs; while the director and his collaborators have published twenty-one papers, mostly included in volumes Nos. 132 and 133 of the publications of the institution.

DEPARTMENT OF MERIDIAN ASTROMETRY

As already explained in a preceding section of this report, the meridian determinations of stellar positions at the temporary observatory at San Luis, Argentina, were finished in January, 1911. This completion in an unexpectedly short time of the more formidable part of the undertaking of the department in the southern hemisphere leaves only the minor task in photometry of measuring the magnitudes (or brightness) of those stars for which this property has not been hitherto measured. This task, requiring only two observers and light equipment, will be subject to small expense.

In the meantime the deductions of stellar positions and motions are proceeding expeditiously in the computing section of the department at the Dudley Observatory; so that the final catalogue, giving precise positions of all stars up to the seventh magnitude inclusive, may be expected to appear in due time. As often happens in such

extensive scientific investigations, many by-products are arising of hardly less importance than the primary ends in view. One of these, deduced from the director's preliminary Star Catalogue, published by the institution about two years ago, shows the mean velocities relative to the solar system of stars of different spectral types. The values derived from the "proper motions" of the catalogue are in striking agreement with those derived for the same stars by Professor W. W. Campbell from direct measurements of the motions of these stars in the line of sight. The remarkable result which is thus brought out from independent investigations is that the speed of a star through space increases with its age. Attention is here invited to the director's interesting summary of this by-product in his current report, the investigation in full having been published in the *Astronomical Journal*, April 3, 1911. It is of interest to note in this connection that the independent investigations of Campbell, referred to above, were also carried out by aid of grants made by the institution.

NUTRITION LABORATORY

Allusion has been made frequently in previous reports to a prime characteristic in the progress of all of the more highly developed sciences. This consists in the passage from the stage of observation and experiment to the stage of measurement and calculation, or in the transition from the stage of qualitative to that of quantitative knowledge. It is marked by the introduction of the meter, the balance, the thermometer, the telescope, the microscope, etc., and the definite methods of chemistry and physics. The development of the work of the nutrition laboratory affords a capital illustration of this characteristic mode of procedure, and therein we find also the best

justification for confidence in the enterprise.

The staff of the laboratory has been occupied during the year in the construction of new apparatus, in the improvement of apparatus already in use, in numerous researches on pathological and normal subjects, and in the preparation and publication of reports on results already attained. The year has shown also a remarkable increase of interest in the work of the establishment coming especially from members of the medical profession at home and abroad. Several of these have collaborated very effectively in the experiments under way, and the widely general approval of the objects and methods of the laboratory insures the heartiest cooperation from experts in the closely allied fields of physiological and pathological research.

The numerous investigations in progress and the publications issued during the year are reviewed in interesting detail in the director's report. Of the nine publications issued, one (No. 155 of the institution) gives the results of an important study of the variations of temperature in different parts of the human body. Of equal popular and technical interest also are the results, recorded in another paper, of experiments on men to determine the effects of breathing air rich in oxygen content.

THE SOLAR OBSERVATORY

By reason of the absence on leave of Professor Hale, the varied work of this observatory has been in general charge of Mr. Walter S. Adams, who, as acting director, has prepared the report of progress for the past fiscal year as well as that for the year 1909-1910. Quite fortunately the affairs of the observatory have proceeded without serious delay during Professor Hale's absence, and it is gratifying to announce that his health was so far restored as to permit

him to return to his duties October 1, 1911.

Although the construction and equipment of the observatory are still incomplete, the members of the staff are making rapid progress with their programs of solar, stellar, and physical observation and of computation and deduction. Thus the attainment of tangible results proceeds along with the development and installation of equipment. Attention is invited to a list of such results, attained during the year, cited in interesting detail by Mr. Adams in his report, but too long for an abstract in this place. It need only be said of them here that they justify expectations and that they increase confidence in the capacity of the establishment to advance astrophysical science.

The observatory has now, nearly fully equipped and in use, four highly effective telescopes: the Snow, horizontal, 30-inch reflector; the two tower-telescope refractors; and the 60-inch reflector mounted equatorially. The 150-foot tower telescope, together with its auxiliary apparatus, constitutes the most important addition of the year in the way of equipment. Varied use of the 60-inch equatorial proves it to be alike effective in visual, photographic, and spectroscopic work. It is especially penetrating in its capacity to reveal the characteristics of globular star clusters and spiral nebulae.

In view of the repeated failures of the contractors of St. Gobain, France, to cast a perfect disk for the 100-inch "Hooker telescope," it was determined to try the imperfect disk furnished by these contractors, but not accepted, four years ago. Accordingly an agreement was entered into with the makers to try shaping the disk, and to pay therefor in case it proves sufficiently stable after adequate trial. This work was begun early in the year, and good progress has already been made, although some delay

must result by reason of the illness of Professor Ritchey and his chief assistant in this delicate and laborious task. In the meantime the glass-founders of St. Gobian are unremitting in their efforts to secure a perfect disk.

It is with deep regret that the observatory and the institution are called upon to record the unexpected death, on May 24, 1911, of Mr. John Daggett Hooker, to whom the enterprise of the 100-inch telescope owes its inception. His intelligent interest in and appreciation of the work of the Mount a gift of \$50,000 in 1906 for the purchase of a disk and for the shaping of it for a 100-inch reflecting telescope. Unfortunately the difficulties in the way of casting so large a disk of glass, together with his untimely death, have prevented him from realizing his desire to see this telescope in use. But if the enterprise succeeds, as now seems quite hopefully probable, the observatory and the institution will be glad to link the constancy of his faith in scientific investigation to the constancy of the stars by means of diligent applications of the "Hooker telescope" to astronomical research.

DEPARTMENT OF TERRESTRIAL MAGNETISM

The magnetic survey of the globe undertaken by this department is proceeding effectively on both land and sea. Observations of the magnetic elements of declination, dip and intensity have been made at numerous points on the continents of Asia, Africa, Australia, Europe, South America and on the Polynesian Islands; while the non-magnetic ship *Carnegie* has secured a large quantity of data of immediate practical utility to navigation and of still greater importance, doubtless, in their relations to the general problem of terrestrial physics.

At the end of the previous fiscal year the

Carnegie was en route from the mouth of the Amazon to Rio de Janeiro. After visiting the ports of Rio de Janeiro, Montevideo, Buenos Aires and Cape Town, she arrived at Colombo, Ceylon, June 7, 1911. Having started on her present circumnavigation cruise June 20, 1910, her arrival at Colombo marked the end, approximately, of the first year out. During this year she traversed upwards of 23,000 nautical miles, measuring magnetic declinations at 252 different points, and dip and intensity at 172 different points at sea. In addition to this work, corresponding complete determinations were made on land at seven ports and intercomparisons of magnetic instruments were made at three ports.

Unexpectedly large errors have been found almost everywhere, except in the south Atlantic Ocean, in the best compass sailing charts now in use. This is especially the case in the Indian Ocean, for which some recently issued charts are in error as much as 4° to 6° in the "compass variations" assigned. To meet the pressing needs of mariners for more trustworthy charts, the data obtained by the *Carnegie* are promptly furnished to the hydrographic establishments of the world engaged in the publication of magnetic charts. It appears from the investigations of the department that the chief source of the errors in existing charts lies in a lack of knowledge of the secular variation of the magnetic elements. It is worthy of note, also, in this connection that observations of atmospheric electricity and atmospheric refraction have been carried on during this voyage of the *Carnegie*. The importance of precise navigation in recent times gives special interest to the outstanding uncertainties due to atmospheric refraction.

Expeditions for land determinations of magnetic data have been made to many

countries and to many islands. The most extended of these are that carried out by Mr. Stewart in traversing the length of the Amazon River and that by Mr. Sligh in Asia Minor, Turkey, Arabia, Greece, Tripoli, Tunis and Algeria. The director of the department, on his way to meet the *Carnegie* at Colombo, made observations at Tau Island, of the Samoan Group, on the day of the total solar eclipse, April 28, 1911; and also at six other island stations in the course of his voyage.

The office work of computation and compilation of results and of the construction and testing of instruments has proceeded simultaneously with the operations on land and sea. A complete collection of the data obtained since the establishment of the department, including those of the cruises of the *Galilee* and *Carnegie*, will be ready for publication by the end of the present calendar year. Three portable magnetometers have been completed and four others are under construction, while various improvements to instruments and apparatus in use have been made, along with all current repairs, in the construction and repair shop of the department.

INVESTIGATIONS OF RESEARCH ASSOCIATES

Between fifty and sixty research associates have carried on investigations under the auspices of the institution during the year, either by aid of grants made directly to them or for the purpose of publishing results of their investigations. Several of these associates have been connected with the departments of investigation. Many collaborators have also participated in the researches carried on under this head, and the fields of investigation are numerous and of very diverse kinds. An idea of the extent and variety of this work can be best gained by consulting the reports, in the current Year Book, of the individual investigators, by reference to the annual list

of publications of the institution and the general bibliography of the year. As indicating the diversity of these investigations, attention may be called to two remarkable publications in widely different fields. One of these is a treatise on dynamic meteorology and hydrography, by Professor V. Bjerknes, of the University of Christiania, and marks a noteworthy advance in this difficult branch of mathematical physics. Part I. of this work has been issued and Part II. is now in press. It is interesting to note, also, that permission has been given to a foreign publishing house to bring out an edition of this work in the German language. The other work referred to is entitled "The Polynesian Wanderings," by Mr. William Churchill. It attempts to trace the migrations of the Polynesians in the Pacific Ocean by means of a critical examination of the philological contents of their language. Mention may also be made in this connection of progress in the publication of the Classics of International Law, one work of which—namely, that of Richard Zouche—having been completed.

CHARLES X. DALTON

THE passing of Charles X. Dalton removes a personality familiar not only to a large circle of scientists throughout the country but to many of Boston's leading business men, with whom he had a large acquaintance owing to his association with that eminent optician, the late Robert B. Tolles.

Born in Philadelphia in 1840, Mr. Dalton learned his trade as an expert mechanician from a German instrument-maker of that city. In his early days he worked in the factory of Joseph Zentmeyer, the well-known microscope manufacturer, and during the Civil War, served as an army nurse. At the close of the war, he entered the employ of Tolles, and later (1867) was associated with him in the Boston Optical Works.

This enterprise, while never profitable financially, owing its existence for many years to the liberality and public spirit of a few wealthy citizens of this city, was epoch making for the industry, nevertheless; for the microscopes and small telescopes produced in its dingy shop attracted the attention of the whole scientific world and set standards not only for America, but Europe as well. To Mr. Dalton was entrusted the making of all the metal work which embodied the intricate designs of the great optician.

The freely spoken encomiums of the best instrument-makers of Europe attesting to the superiority of workmanship of the Tolles objectives have more than once made special mention of the excellence of their metal work. This Boston company was all too short lived, owing to the untimely death of Tolles in 1883, but many of Tolles's instruments, treasured to-day by connoisseurs as still unequalled, remain as fitting memorials of the genius of this master optician, and will also keep alive the memory of the clever mechanician whose deft workmanship contributed so much to their excellence.

For one or two decades preceding and immediately following the Civil War there was a widespread popular interest in the microscope among cultivated people as a form of amusement, although much serious scientific work was done likewise. Microscope clubs were common throughout the land, and in England as well. Many became experts in microscope technique and there was an active demand among the wealthier of these enthusiasts for the best instruments that could be produced, irrespective of cost. This stimulated the instrument-makers of England and America to use the utmost skill and best workmanship, and in the hands of famous opticians, among whom Tolles with his giant genius shone preeminent, the microscope was carried to a high degree of elaboration and efficiency. It was under such conditions that Charles Dalton was inspired to use his skill and cunning as an artificer of metals. Dalton was not a workman for wages only. He had that true love of his craft and a pride in his workman-

ship which characterized the true craftsman and which is vital for best results. He would never do mediocre work and was his own severest critic of his product. He made many of his tools and appliances and accomplished much by primitive but cunning methods which are a lost art to the mechanician of to-day, or made possible only by the use of elaborate tools.

The death of Tolles practically ended the work of the Boston Optical Co. A few instruments designed by Tolles were completed by his workmen, but no successor could be found to give adequate expression to the original genius of the master. For many years Mr. Dalton has carried on the business in the old Hanover Street building, making repairs on the Tolles instruments which have been sent to him as the only one competent to make them and doing a general business in the sale and repairs of optical and other delicate instruments.

The wane in popular interest in the microscope as a recreation for the dilettante and the cheap compact "continental" instrument, of high optical efficiency but reduced to the simplest terms as to finish and accessories, in short a laboratory tool designed solely for the special work at hand has become common in our schools and colleges. Such instruments of good quality are now turned out by the thousands by the great manufacturers, using labor-saving machinery and modern systems of divided labor, and a good microscope is cheaper to-day than formerly. The elaborate instruments of Tolles and other great opticians of the past generation, instruments in which cost was subordinated to every detail which added to convenience and efficiency, masterpieces of ingenious and perfect workmanship, are no longer made, and with them is disappearing the old-time workman whose knowledge and craft partook almost of the dignity of a profession.

No doubt this condition is quite in accord with modern ideas and economics, but there may be some who view the changing times with some regret, some who have known the spirit and moral fiber of the old craftsman

and rejoiced in the fruits of his workmanship. May be there are some who still feel that there is a dignity and fitness in studying the beautiful in science for its own sake even by the untrained, and take the microscope as more than a laboratory tool.

The originality and workmanship of these old instrument-makers are still felt and long will be felt in the industry. European microscopes which till comparatively recently have been of the most primitive types, are gradually changing in design by adoption of many of the original optical and instrumental features of Tolles and his contemporaries, bearing witness to the permanence and soundness of their work.

Mr. Dalton in his later years made most of the repairs on the microscopes and chemical balances of the Harvard Medical School, Massachusetts Institute of Technology, Wellesley College, and in fact of most of the educational institutions in and about the city, his work in this line occasionally taking him as far as Vassar.

Through this business, he had a wide circle of acquaintances and will be missed by many who have looked with pleasure on the coming of the genial little gentleman who with his clear complexion and bright eye looked seventy years young, a man whose scrupulous cleanliness of person but exemplified his own blameless character, a normal man and the highest type of American craftsman.

GEO. W. ROLFE

THE SECOND INTERNATIONAL CONGRESS OF ENTOMOLOGY

THE first International Congress of Entomology, held in Brussels on August 1-6, 1910, was an unqualified success. It was well supported by entomologists of all countries, both theoretical and practical, and also by many governments and institutions, which are at last beginning to realize the profound importance of this science in medicine and in agriculture. The membership was nearly 400, and upwards of 300 actually attended the proceedings. The results of the deliberations are being published in two volumes, the first being

devoted to the proceedings and discussions, the second to the numerous memoirs contributed by many authorities upon a great variety of subjects, including papers devoted to pure and to economic entomology. The volume of memoirs (515 pages, 27 plates) is now published and issued to members. The volume of proceedings will follow shortly.

It was decided at the first congress that the second congress should be held in 1912, and the following meetings every three years from that date, so that in future the International Congress of Entomology will be held one year before the International Congress of Zoology. The second congress will therefore be held at Oxford on August 5 to 10, 1912, under the presidency of Professor E. B. Poulton, D.Sc., F.R.S. A reception committee has been formed, consisting of:

Dr. F. A. Dixey, F.R.S. (Chairman).

Professor G. C. Bourne, F.R.S. (Professor of Zoology).

Professor H. L. Bowman, D.Sc. (Secretary to the Delegates of the University Museum).

Professor E. B. Poulton, D.Sc., F.R.S. (President of the Second Congress).

Geoffrey W. Smith, M.A. (Fellow of New College).

Commander J. J. Walker, M.A. (Secretary of the Entomological Society of London).

H. Eltringham, M.A. (Cant.), M.A. (Oxon.), and G. H. Grosvenor, M.A. (Secretaries).

It is hoped that the reception committee will be able to arrange for members of the congress to have rooms in the colleges at a moderate price, but this privilege will be available for gentlemen only. In order to facilitate the arrangements, it is requested that ladies and gentlemen who propose to join and attend the Congress send in their names as early as possible to the general secretary of the executive committee, who will be happy to give any further information. Ordinary members who pay £1 (25 francs) will receive all publications of the congress. Ladies and children accompanying members will, on payment of 10s. (frs. 12.50) each, have all privileges of members except that of receiving the publications. Life members who pay a com-

position of at least £10 (frs. 250), will receive free all future publications of the congress. The funds received in respect of Life Compositions will be invested, and only the interest will be at the disposal of the executive committee. Sir Daniel Morris, D.Sc., and the Hon. N. Charles Rothschild, M.A., F.E.S., have kindly consented to act as trustees of the funds. Members who propose joining the congress, or presenting papers, are requested to address the general secretary of the executive committee, Malcolm Burr, D.Sc., care of Entomological Society of London, 11 Chandos Street, Cavendish Square, London, W.

ANTARCTIC EXPLORATIONS

As every one knows from the daily press the Norwegian explorer, Captain Roald Amundsen, who made the first northwest passage ever accomplished by ship, has added to his laurels by reaching the South Pole. He verifies Shackleton's report that the pole is on an ice-capped plateau more than ten thousand feet above the ocean. Amundsen also discovered ranges of mountains, the peninsularity of King Edward VII. Land, and the origin of the oceanic ice-cap, known as Ross's Barrier. As soon as information as to the extent of the scientific work is received it will receive proper notice from SCIENCE.

Of the highest importance to the standing of American antarctic explorers is the information that the Australian antarctic expedition, in the ship *Aurora*, has verified in a general manner the accuracy of the discoveries of Captain Charles Wilkes, U. S. Navy, in 1840, of the Antarctic Continent. The leader of this expedition was Dr. Douglas Mawson, well-known to the readers of SCIENCE through his location of the South Magnetic Pole, in 72° 24' S., 155° 16' E. (SCIENCE, May 10, 1910). Dr. Mawson landed, February 19, on the glaciers of Adelie Land, with a party that remains there during the Antarctic winter. Another party under Dr. White is pursuing its scientific work at Termination Land, where it landed January 18. It is hoped that this confirmation of the reliability of Ameri-

can work will be set clearly before the American people as soon as details are obtainable.

SCIENTIFIC NOTES AND NEWS

REAR ADMIRAL GEORGE WALLACE MELVILLE, U.S.N., retired, known for his Arctic explorations and eminent as a mechanical engineer, formerly engineer in chief of the U. S. Navy, died on March 18, aged seventy-one years.

DR. W. H. WILEY has resigned the position of chief of the Bureau of Chemistry of the Department of Agriculture, which he has held since 1883.

AMONG the degrees conferred, on the occasion of the exercises commemorating the one hundred and twenty-fifth anniversary of the University of Pittsburgh, were the following on men of science: The doctorate of laws on Edgar F. Smith, provost of the University of Pennsylvania; N. L. Britton, director of the New York Botanical Garden, and L. O. Howard, chief of the Bureau of Entomology and permanent secretary of the American Association for the Advancement of Science. The doctorate of science on Ira N. Hollis, professor of engineering at Harvard University; C. F. Scott, professor of electrical engineering at Yale University; H. D. Campbell, dean of Washington and Lee University; A. D. Mead, professor of comparative anatomy at Brown University; C. M. Snelling, dean of the University of Georgia; R. K. Duncan, director of the department of industrial research of the University of Pittsburgh; James Ewing, professor of pathology at the Cornell University Medical School, and Milton J. Greenman, director of the Wistar Institute of Anatomy.

THE Smithsonian Institution was represented at the centennial celebration of the founding of the Academy of Natural Sciences of Philadelphia this week by Dr. Charles D. Walcott, Dr. Richard Rathbun, Dr. Frederick W. True and Dr. Theodore Gill. Dr. Leonhard Stejneger represented the U. S. National Museum, and Mr. F. W. Hodge the Bureau of American Ethnology on this occasion.

A PORTRAIT of Dr. James Tyson, emeritus professor of medicine, painted by Mr. Hugh H. Breckenridge, has been presented to the University of Pennsylvania.

DR. WILHELM WUNDT, professor of philosophy at Leipzig, has been made a knight of the Prussian order "pour le mérite."

LIEUT.-COLONEL D. PRAIN, F.R.S., director of the Royal Botanic Gardens at Kew, has been elected a foreign member of the Royal Swedish Academy of Sciences, to fill the vacancy left by the death of Sir Joseph Hooker.

DR. R. RUEDEMANN, assistant state paleontologist of New York, has been elected a member of the Academy of Sciences at Halle.

M. LOUIS DE LAUNAY, professor of applied geology in the Paris School of Mines, has been elected a member of the Paris Academy of Sciences.

DR. KRÜMMEL, professor of geography at Marburg, has been elected an honorary member of the Geological Society of Frankfurt.

DR. THEO. B. COMSTOCK has resigned as secretary and chief engineer of the Board of Public Utilities of Los Angeles.

At the end of the current year Professor Frank Fanning Jewett will retire under the Carnegie Foundation from the headship of the department of chemistry of Oberlin College after thirty-two years of active service. Professor Jewett received the A.B. from Yale in 1870, followed by the A.M. in 1873. He then studied at Göttingen and the University of Berlin. His first teaching appointment was that of assistant to Dr. Wolcott Gibbs at Harvard in 1876. The next four years were spent as professor of chemistry in the Imperial University of Tokyo, Japan. He was then called to head the department at Oberlin.

THE eight men who have influenced Wisconsin agriculture most are in the order named: Professor W. A. Henry, Professor Stephen M. Babcock, ex-Governor W. D. Hoard, Hiram Smith, Professor R. A. Moore, Dean H. L. Russell, Professor F. H. King and George McKerrow, according to the articles

submitted by students of agricultural journalism in the University of Wisconsin.

MR. F. G. FIGG, formerly first assistant at the Colonial Observatory, Hongkong, has been appointed director of the Mauritius Observatory.

PROFESSOR AUG. CRAMER, of Göttingen, has been appointed the successor of Professor Ziehen, as director of the psychiatric clinic of the University of Berlin.

DR. FINGERLING, of the Agricultural School at Hohenheim, has been elected director of the Agricultural Experiment Station at Möckern.

MR. SELSKAR M. GUNN, assistant professor in the department of biology and public health of the Massachusetts Institute of Technology, has become the editor of the *Journal* of the American Public Health Association, succeeding Dr. Burt R. Rickards.

DR. WALTER S. TOWER, of the University of Chicago, sailed from New York, on March 20, for South America, where he intends to spend six months studying the economic geography of Argentina, Chile and southern Brazil.

At the summer session of the Venice Marine Biological Station of the University of Southern California from June 24 to August 2, Professor Charles L. Edwards will give a course of lectures upon marine biology and direct the work in the laboratory and upon the motor sloop *Anton Dohrn*.

DR. WILDER D. BANCROFT, professor of physical chemistry at Cornell University, lectured before the Columbia University Biochemical Association on March 15. His subject was "The Study of Environment."

At the annual meeting of the Columbia Chapter of Sigma Xi, Professor Wm. J. Gies, gave an address on the chemistry of digestion.

PROFESSOR W. K. HATT, of Purdue University, delivered an exchange lecture before the students and faculty of the College of Engineering of the University of Illinois, March 6, on "Timber Preservation." He also gave an address before the freshmen of the College on "Mountain Railways."

BEFORE the Chemical Society, London, on February 29, Sir William Ramsay delivered a memorial lecture in honor of Henri Moissan, the eminent French chemist who died five years ago.

THE death is announced of Dr. Dittmar Finkler, professor of hygiene at Bonn; of Dr. Richard von Stoffela, professor of medicine at Vienna; of Professor Richard Andree, the geographer of Brunswick, and of Dr. A. Grünhegen, professor of medical physics at Königsberg.

MR. JAMES J. HILL has announced that he will build and maintain in St. Paul a reference library to cost not less than \$350,000.

THE *Medical Record* states that at the fourth annual meeting of the national committee for mental hygiene, held in New York, on February 17, a campaign was inaugurated which has as its object the improvement of conditions affecting the mentally afflicted. An anonymous gift of \$50,000 enables the committee to start the work without delay. Dr. William L. Russell, superintendent of Bloomingdale Hospital, was appointed chairman of a subcommittee which will survey the national field, under the personal leadership of Dr. Thomas W. Salmon, of the United States Public Health and Marine Hospital Service, who has been granted leave of absence for this purpose. Dr. Llewellys F. Barker, of Johns Hopkins University, was elected president of the committee.

At a meeting held on Tuesday evening, February 20, the Minnesota Pathological Society was formed, with nearly fifty charter members present. The following officers were elected:

President, Dr. A. S. Hamilton.

Vice-president, Dr. J. S. Gilfillan.

Secretary, Dr. H. E. Robertson.

Treasurer, Dr. J. F. Corbett.

Censors, Drs. F. L. Adair, R. H. Mullin and H. A. Tomlinson.

THE American Scenic and Historic Preservation Society takes pleasure in announcing that it has been accorded by the United

States Department of the Interior the honor of exhibiting for the first time a collection of pictures of National Parks, made by the Interior Department for the purpose of illustrating the work of the federal government in the protection of regions of great landscape beauty and natural phenomena. By the courtesy of the National Arts Club of New York, the pictures will be hung in its galleries at No. 15 Gramercy Park, and will be on exhibition under the auspices of this society from Wednesday, March 13, until and including Saturday, March 30. During this period the public will be admitted without cards on week days, from 10 A.M. until 6 P.M. After this exhibition the pictures will be sent on a tour for similar display in different parts of the United States.

THE statement appearing in the issue of *SCIENCE* of February 2, on page 197, regarding the passage of a resolution by the American Economic Association in favor of an International Commission on the Cost of Living, was inaccurate. At a round table discussion led by Professor Fisher the persons present voted unanimously in favor of such a commission, but owing to a provision in its constitution providing that the Economic Association will not commit its members to any position on practical economic questions, no formal resolution was passed.

THERE will be a U. S. Civil Service examination on March 30, for the position of dairy chemist, in the Bureau of Animal Industry, at a salary of \$1,800.

AN astronomical bulletin from the Harvard College Observatory states that seven excellent photographs of the spectrum of Nova Geminorum No. 2 were taken at Harvard on March 13 and the same number on March 14. A marked change occurred in the spectrum, the photographs on the first date showing only dark lines while the hydrogen lines $H\beta$, $H\gamma$, $H\delta$ and $H\epsilon$ have well marked bright lines on the edge of greater wave length, on the second date. Those last photographs closely resemble those of Nova Persei No. 2, on Feb-

ruary 24, 1901. The bright lines seen with the slit spectroscope at Ann Arbor may have been too narrow on March 13, to show with an objective prism. The brightness of the star has increased, and was about 3.5 magn. on March 14.

DOFLEIN's excellent "*Lehrbuch der Protozoenkunde*," the most complete of modern works of its kind, met with such immediate success that scarcely a year had elapsed before he began a third edition. The preface of this edition is dated September 3, and the book, published by Fischer, has been on the market for two or three months. So rapid has been the advance of protozoology, that not a chapter has escaped revision, or rearrangement with additions, the net result being an increase in number of pages from 914 to 1,043. In addition to the many new species introduced there is a new chapter on species, variation and inheritance. The author's attitude on special problems has not been changed and the parasitic forms, as before, receive the bulk of attention.

A MEETING of the members of the Central Branch of the American Society of Zoologists will be held at the University of Illinois, Urbana, Illinois, in the new Natural History Building, on April 4, 5 and 6. Thirty-five members have expressed their intention to be present at this meeting, but it is expected that a large number will be able to attend. The meeting will begin with a smoker at the University Club, on April 4, when President Edmund James will address the society. The formal program will begin on Friday morning at 9:30, with an afternoon program at 2. Professor George Lefevre will deliver the presidential address at the banquet at the University Club on Friday evening. The Saturday morning program will begin at 9:30. There will also be an afternoon program, if it seems necessary. Members of the society who expect to present papers should send titles to the secretary, Professor H. V. Neal, Knox College, Galesburg, Ills., not later than March 21. The printed programs will be sent out about the twenty-fifth inst.

THE Tennessee Academy of Science was organized at a meeting held in Nashville recently. A constitution was adopted and steps taken to hold an initial meeting in April. At this meeting in addition to a regular program the officers of the academy will be elected and steps taken to extend the membership so as to include all white persons in the state who are interested in any phase of science or cognate subjects. Meetings are to be held annually on the Friday following Thanksgiving. For the present the movement centers in the office of the state geologist at Nashville.

THE Cooper Ornithological Club, an organization of western bird students, has recently established two permanent committees for the conservation of wild life. The chief objects of the club in doing this may be stated as follows: (1) To cooperate with other organizations, including the State Fish and Game Commissions and the Federal Bureau of Biological Survey, to the end that the wild life yet remaining in state and nation may be more effectively protected. (2) To work at all times for an enlightened public sentiment along lines of the conservation of wild animals. Following is the personnel of the committees. For the northern division of the club, W. P. Taylor, Museum of Vertebrate Zoology, Berkeley, *chairman*; H. C. Bryant, University of California; J. S. Hunter, State Fish and Game Commission, San Francisco; H. W. Carriger, San Francisco, and John W. Mailliard, San Francisco. For the southern division, Frank S. Daggett, director Museum of Science, Arts and History, Los Angeles, *chairman*; J. Eugene Law, Hollywood; H. J. Lelande, Los Angeles; Howard Robertson, Los Angeles, and G. Willett, Los Angeles.

A SERIES of seven lectures on "Public Health" subjects are in progress at the University of Illinois. These lectures, given on Wednesdays and Fridays, beginning March 13, are as follows: "Sociological Aspects of Public Health," by Dr. Henry B. Favill, of Rush Medical College, Chicago; "Influence of Water Supplies on Public Health," by Professor Edward Bartow, University of Illinois;

"How Not to Be Sick," by Dr. John N. Hurty, secretary of the Indiana Board of Health. "Bovine Tuberculosis and Its Relation to Public Health," by Dr. Mazyck Porcher Ravennel, professor of bacteriology at the University of Wisconsin; "The Influence of Disease on Civilization," by Dr. Victor C. Vaughan, dean of the department of medicine, University of Michigan; "Ventilation of Schoolrooms and Bedrooms," by Dr. William A. Evans, of the Chicago *Tribune*; "Milk," also by Dr. William A. Evans.

ABOUT forty students of the University of Illinois, pursuing courses in Railway Engineering or Railway Administration, have joined in forming the Railway Club of the University of Illinois. The object of the club is to provide for informal meetings for a discussion of railway problems and to promote good fellowship among its members. The officers for the present semester are: H. E. Marquette, president; A. C. Van Zandt, vice-president; W. C. Sadler, secretary; A. S. Nevins, treasurer; E. L. Tinzmann, sergeant-at-arms.

A NEW map of the state of Illinois on a scale of approximately eight miles to the inch is ready for distribution by the State Geological Survey. It is prepared in three colors so as to represent drainage features in blue; railroads, land lines, towns, etc., in black, and county boundaries and figures showing altitudes above sea level for various towns in red. This map eliminates the errors of early land surveys, so that places are now shown with correct latitude and longitude. Railroad alignments are all highly accurate.

UNIVERSITY AND EDUCATIONAL NEWS

THE Massachusetts Institute of Technology has received from a donor whose name for the present is anonymous, a gift of two and a half million dollars for the erection of the buildings on its new site.

ACCORDING to the Boston *Transcript*, Harvard University has received subscriptions amounting to \$1,200,000 for the erection of freshmen dormitories.

MT. HOLYOKE College has received an anonymous gift of \$50,000 for the endowment fund which now amounts to about \$370,000.

THE University of Toronto has received from Mrs. William Freeland the gift of an endowment for a fellowship in anatomy in memory of her father, the late Dr. James H. Richardson, who for many years was professor of anatomy in the Toronto School of Medicine and the University of Toronto. The fellowship is to be known as the James H. Richardson research fellowship in anatomy, and is of the value of \$500. It is open to graduates of recognized universities and medical colleges, and to students of the University of Toronto who have completed the third year of the medical course in that institution. The holder of the fellowship will be required to devote his entire time during the tenure of the fellowship to investigation in anatomy under the direction of the professor of anatomy in the University of Toronto.

THE New York School of Applied Design for Women has received a bequest of ten thousand dollars by the will of Miss Cora F. Barnes. Also a Scholarship in Perpetuity, of one thousand dollars from Miss Catherine A. Bliss.

It should have been stated in SCIENCE last week that Dr. Horace David Arnold had been appointed dean of the Graduate School of Medicine of Harvard University, not of the Harvard Medical School. The graduate school of medicine is a new department of the university, being a part of the faculty of medicine. It should also have been stated that Dr. Edward Hickling Bradford would retire from the chair of orthopedic surgery and become professor emeritus.

THE Bryn Mawr European fellowship awarded to the student receiving the highest grade has been given this year to Miss Nora Cam, who has specialized in mathematics and physics. The president's European fellowship has been awarded to Miss Bernette Lois Gibbons, a student of chemistry.

CHAS. H. TAYLOR, professor of mineralogy at the University of Oklahoma, has been pro-

moted to the head of the department of geology. At the same meeting Mr. Irving Perrine, instructor in geology at Cornell University, was appointed associate professor of geology.

DR. PERCY E. RAYMOND, formerly of the Carnegie Museum, Pittsburgh, and more recently paleontologist to the Geological Survey of Canada, has been appointed assistant professor of paleontology at Harvard University, and curator of invertebrate paleontology in the Museum of Comparative Zoology.

DISCUSSION AND CORRESPONDENCE

NUMBER OF STUDENTS PER TEACHER

TO THE EDITOR OF SCIENCE: In the January 26 number of SCIENCE is a note on the "Number of Students per Teacher," by Professor A. S. Hathaway, in which he says:

It appears to me that the only correct way to determine the average number of students handled per teacher in any school is to divide the number of student hours per week by the number of teacher hours per week.

This formula might simplify the mere mathematics of the situation, but it would most certainly fail to give just the information desired—the strength of the teaching force in an institution, or, in the words of Professor Hathaway, "the average number of students handled per teacher." It is then far from being a correct way, to say nothing of the only correct way.

The following illustration will show how the method suggested would miss the very purpose of our calculations. Suppose that a college of 300 students, averaging 15 hours recitation per week each, has 5 instructors, each teaching 20 hours per week; then the result would be, according to the formula suggested,

$$300 \times 15 \div 5 \times 20 = 45 \text{ "students handled per teacher."}$$

Now, another college with the same number of students, each reciting also on the average 15 hours per week, but with 10 teachers, each meeting classes 10 hours per week, would

show the same result; or a college of 225 students, averaging 20 recitations per week, with 10 teachers, each having 10 classes per week, would show 45 "students handled per teacher." Certainly the teaching forces of these schools would not be equally strong.

It is not particularly the average number of students per class, or recitation, that we are after. Even if this were our object we should find the matter more complicated than Professor Hathaway has supposed. Some "courses" require a proportionately larger number of recitations per hour's credit than others. And how should we treat laboratory work, which can not with fairness be classed with recitations? Some laboratory courses require very little outside work, but more work in the laboratory, while others require a considerable amount. What complicates the matter still more, is the fact that in many cases student assistants direct such courses in large part while in others professors attend to the work themselves. These are only a few of the complications one actually finds.

The class work does not afford the only opportunity for the teacher to assist and stimulate the student; and any scheme based upon class work alone would not only do an injustice to some of the very best of our educational institutions, but would also tend to emphasize unduly a practise that is doubtless already carried too far.

JOSEPH PETERSON

UNIVERSITY OF UTAH,
SALT LAKE CITY

ARE TEACHERS ENTITLED TO COMPLIMENTARY DESK COPIES OF TECHNICAL BOOKS?

HERE is the teacher's point of view:

The texts which I am using are of no personal benefit to me. I am supposed to use the latest edition, and to change the text once in a while. I do not see how I can well afford to buy them. The publishers get big profits out of the students and can well afford to give a copy to the teacher, while, on the other hand, the teachers' salaries are meager. And as to new reference books and practical engineering books, I can not always order them

for the college library without first seeing the book. So the only way left me is to ask publishers for a desk copy, however humiliating this may be.

Here is the publishers' point of view:

We consider it a good business policy to send a desk copy to the professor in charge of a course where a considerable number of our books are used. We also send copies of new books to professors prominent in their respective fields, hoping for returns on account of their recommendation. But the privilege of free books is greatly abused by some teachers, who finally succeed in accumulating fair-sized libraries of free books. Again, frequently we get requests for desk copies not only from the professor in charge, but also from all the instructors who assist him in his classes. Moreover, these requests come from the same schools year after year, showing that the instructors are allowed to appropriate the books. This we consider an unnecessary and unjust burden upon the retail price of technical books. At the same time we hesitate to refuse such requests, for obvious reasons. One of the worst features of the situation is that requests for desk copies come from colleges from which only two or three copies are ordered later on.

Here is the writer's point of view:

The question raised is one of equity and justice to both the teachers and the publishers. Moreover, the dignity of colleges of engineering is to be considered. Since this is a matter of ethics, equally applicable to practically all engineering colleges, it ought to be decided by the Society for the Promotion of Engineering Education. Other national engineering societies have committees on professional ethics, and this is evidently a problem for such a committee. A resolution approved by the society will have a great moral effect with both teachers and publishers, and would be an important step towards the solution of this vexed problem.

I feel rather strongly that all requests for free copies of books should be pronounced unprofessional and undignified. If a teacher does not care or can not afford to buy a book,

the college ought to buy a copy and place it at his disposal as long as he needs it in his teaching, the book remaining the college property. The college provides the teacher with an office and its furniture, heat, light, stationery, lantern slides, lecture apparatus, etc. To provide text-books when requested would be but a small additional expense, but it would mean a great deal for the teachers, and would put the whole matter upon a dignified business-like basis. As it is now, the situation reminds one of the railroad passes, now fortunately prohibited by law.

As to new engineering books, it is to the advantage of colleges, publishers and teachers that an opportunity should be given to those engaged in teaching to see and to inspect all noteworthy new books relating to their respective subjects. This end can be attained easily without sending out complimentary copies. The publishers of engineering books could arrange to move a few copies of new books along definite "circuits," each comprising several colleges. In each college it would be the duty of the dean or of the head of the respective department to bring the new book to the attention of the faculty and to consider the advisability of ordering a copy for the college library. There is nothing compulsory in this scheme; it would be a privilege offered by the publishers, and if certain teachers should not care to avail themselves of this advantage that would be their own business.

As stated before, in my opinion it would be to the best advantage of all concerned if a distribution of complimentary books were done away with altogether, except perhaps as voluntary and unsolicited gifts from authors and publishers to their friends. However, with the above scheme of "circuit books" even these gifts would become less and less necessary, because in most cases a person merely wishes to know that a certain book has been issued and also likes to know its scope and plan. After that, it mostly becomes a dead weight in his library.

Should the suggestions made above be deemed too radical in view of the established custom and the conditions of the trade, I

would suggest for the consideration of the Society for the Promotion of Engineering Education the following partial improvement in the method of requests for desk copies:

1. All requests for desk copies to be sent to the publishers only by the deans of colleges, and not directly by individual teachers or heads of departments. This would insure more justice, uniformity and dignity.

2. All free copies to remain the permanent property of the college, and not of individual teachers. This will reduce the number of requests to a reasonable amount.

3. Whenever possible, teachers and colleges ought to purchase books and avoid asking for complimentary copies.

V. KARAPETOFF

CORNELL UNIVERSITY

SCIENTIFIC BOOKS

Melanesians and Polynesians; Their Life Histories Described and Compared. By GEORGE BROWN, D.D. London, MacMillan & Co. 1910. Pp. 451, 70 illustrations. Price, \$3.00.

The work is a comparative study of two groups of mankind generally supposed to have next to nothing in common. The relationship of these groups, however, has been maintained by some students since the epoch-making explorations of Wallace, who considered the Pacific peoples as variants of one race. Mr. Brown's theory, based principally on the languages concerned, in which he is an authority, is that a Negrito substratum formerly occupied the East Indies as far west as Borneo, also the continental skirts, and this stock became diluted by infusion of blood from India. Later the pressure of Malay tribes drove them out into the Pacific, the Polynesians having the greatest admixture of a light brown stock drifting to some point of radiation, perhaps Manua of the Samoan group, and the Melanesians, retaining more of the blood of the original black inhabitants, dispersed to the islands where they live at present. The Melanesians are thus regarded as the older, less commingled stock.

His long residence in New Britain and

Samoa and his command of the native languages fit Mr. Brown especially for the work and his opinions are entitled to great respect. The intention to establish by comparison the cultural affiliation of the dusky and fair-brown peoples has produced a most interesting and valuable body of observations charmingly presented in clear English, not only a contribution to science in the way of an almost unique comparative study, but a non-controversial book well worth reading for general information.

WALTER HOUGH

Herpetology of Missouri. By JULIUS HURTER, SR., Curator, Academy of Science of St. Louis, Mo. Pp. 215; 12 pl. relating to structural characteristics.

There have been various *resumés* of the fauna of states, these publications of more or less economic value, but it is genuinely pleasing to note the appearance of the present work in which it is evident throughout that the author has devoted much labor and time in presenting a detailed and practical review. A publication like this stands as a fine example of what should be forthcoming from other workers on local fauna. Carefully systematized it also treats those economic features which greatly enlarge the field of usefulness. Too many of our local scientific workers devote a great amount of time and space to the treatment of synonyms, forgetting that this phase of their subject is of absolutely no interest to the great mass of readers, eagerly awaiting the zoological history of their home territory.

The farmer, the natural science teacher and the younger student will find Mr. Hurter's work of immediate and practical interest, while the technical descriptions are sufficiently elaborate to properly identify any of the species. There is a series of well-prepared plates relating to the mouth characters of salamanders and frogs, the foot characters of the latter, the scalation of serpents and like characters.

Looking through the systematic arrangement, one notes several apparently recent

changes in the nomenclature relating to families and genera. The author of the publication remarks that he has adhered strictly to the "International Rules of Zoological Nomenclature," adopted by the International Congress of Zoology. It seems a pity these adopted rules have been followed by the frequent discoveries that names familiar for the past quarter of a century and more, can no longer be permitted to stand. These never-ending changes and the constant growth of the list of synonyms bring about perplexing conditions, even to the technical worker. Some remedy might result, by accepting as a standard, a monumental world's work like Boulenger's "Catalogue of Reptiles of the British Museum." Time would, of course, elicit modifications, but with a standard agreed upon our technical workers would find more time for investigations along more original and generally valuable lines.

RAYMOND L. DITMARS

NEW YORK ZOOLOGICAL PARK

A REMARKABLE JOURNEY ACROSS THE
SAHARA

ONE of the most daring journeys conceivable on the Sahara has recently been successfully accomplished by Count René le More who, almost alone, went from southern Algeria directly across the desert to Timbuctu. The journey of about 8,000 kilometers altogether, to Timbuctu and return, occupied about 13 months, of which three were passed in Timbuctu.

Leaving Ghardaia in November, 1910, le More reached Timbuctu in the last of April. He returned by nearly the same route. Discarding all precedents in Saharan travel, le More was accompanied by only two persons, a servant and an interpreter-guide, both of whom were Arabs. He had one Touareg riding camel and two small Algerian baggage camels, and carried the minimum amount of baggage, of which two or three American guns formed a prominent and a useful part.

No account of this journey has yet appeared, but in *Le Matin*, January 15, 1912,

there is an interview giving some of the main facts. The route taken in going was by Ghardaia, el Golea, In Salah, Tamanrauet, Kidal to Gan Gao, on the Niger River, thence by the river to Timbuctu. On the return a slightly different course was taken, passing somewhat to the west of Timanrauet, but retracing the previous way from In Salah.

The entire journey was perilous, not only because of the natural dangers attending desert travel, but especially on account of hostile tribes. Soon after le More left Ghardaia, I was told by an officer that the venturesome Frenchman would hardly be able to pass through the Touareg country with so small a company, the Touaregs would surely cut off his head. On the way le More went 29 days, going south from Timanrauet, without seeing any person outside of his own caravan. On the return the little company had exciting adventures in fighting off bands of robbers, coming off with better luck than other travelers through the region. Graves of several unfortunates were seen between Kidal and Gan Gao.

The purpose of the intrepid traveler was to study the country that he might later cross to Timbuctu by aeroplane. As a result he knows the best, or the only situation for relay stations, and much of the conditions attending desert travel, and he considers the project as possible of accomplishment. The result is that le More proposes to cross the desert again, but the next time in the air. Whether this difficult task is finally accomplished by le More remains to be seen, but there is little doubt that in the very near future aeroplanes will not be unknown in the extreme southern part of Algeria, since it is said that the French army in the colony has been actively engaged for several months in working out the details of an aeroplane corps with headquarters at Biskra.

Owing in large part to its relatively high elevation above the sea, the western Sahara is not so intensely arid as the eastern Sahara. In the vicinity of Ouargla and Ghardaia, for example, there is considerable vegetation, especially along the oueds. Le More's photo-

graphs show, also, that much further south, at In Salah and beyond, over half way to Timbuctu, there is a similar condition of affairs. It is probable, however, that the vegetation of the mesa-like areas, the *reg* or the *hamada*, may be barren in the extreme south, since even at Ghardaia there is very little vegetation on such areas. The mid-Saharan country is of the greatest interest botanically since there the Mediterranean element is almost wholly lacking, and the influence of the countries to the south of the desert begins to be felt. We shall await with much expectancy the promised detailed account of this remarkable journey.

W. A. CANNON

DESERT LABORATORY

BOTANICAL NOTES

SUPPLEMENT TO ENGLER AND PRANTL'S ALGAE

THE volume of the "Pflanzenfamilien" containing the Algae (I., abt. 2) was completed fourteen years ago (1897), while most of the parts of which it was composed appeared several years earlier. In 1909 two supplementary Lieferungen were issued by Wille, in 1910 two more were issued by Wille, Kjellman and Svedelius, while two more were issued in 1911 by Svedelius. These have now been brought together by the Leipzig publisher, Wilhelm Engelmann, under the subtitle of "Nachtraege zum I Teil, 2, Abteilung." It covers the period from 1890 to 1910, and so brings the treatment of the Algae down to date.

The first thing one notices is the considerable modification of the schematic chart of the relationship of the families of the green algae. The five groups (classes) are developed from the Flagellata, the Protococcales being the primitive class with *Volvocaceae* as the lowest family. From the latter came the Conjugatae as a side line ending blindly. Above *Volvocaceae* are placed *Tetrasporaceae* which lead by one line through *Protococcaceae* to *Hydrogastreae* and *Valoniaceae*, and by the other to *Ulvaceae*. The family *Valoniaceae* is regarded as the lowest of the class

Siphonocladales, which culminates in *Dasycladaceae* and *Sphaeropleaceae*. From *Valoniaceae* a line reaches *Bryopsidaceae* in Siphonales, culminating in *Vaucheriaceae*. The *Ulvaceae* are the lowest of the Chaetophorales, which pass by several lines to *Chroolepidiaceae*, *Coleochaetaceae* and *Oedogoniaceae* at the summits of as many genetic lines. A significant thing in the treatment of these families of green algae is the association of five families of colorless plants as "Nebenformen" related to *Volvocaceae*, *Pleurococcaceae*, *Protococcaceae*, *Oocystaceae*, and *Oedogoniaceae*, thus adding another step to the movement for the obliteration of the distinction between algae and fungi, and their assembling into new groups on morphological characters.

In passing it may be noted that *Pleurococcaceae* are separated from *Protococcaceae* by the absence of zoospores in the former and their presence in the latter, contrary to some recent algologists. Nor has the author been stampeded into dividing *Hydrogastreae* and in his system *Protosiphon* and *Botrydium* lie peacefully side by side as related genera in the same family. *Characeae* are still so placed as to immediately follow Siphonales, and by this one is reminded of Wille's suggestion of their relationship in his earlier treatment. The revision of the Phaeophyceae was partly made by Kjellman, and on his death it was continued by Svedelius. It thus happens that some of the families are the joint work of the two authors, while in other cases Svedelius alone did all of the work, as in *Sphacelariaceae*, *Laminariaceae* and *Fucaceae*. The revision of the Rhodophyceae also is the work of Svedelius. Here the treatment is necessarily the same as that of Schmitz and Hauptfleisch fourteen to fifteen years earlier. However in the difficult family of the *Corallinaceae* the genera of the earlier treatment are freely broken up into smaller ones in accordance with the trend of recent opinion, resulting in the recognition of twenty-four genera instead of nine, with a considerable shifting of their places in the family.

NOTES

WITHIN the past two years Dr. W. C. Coker has rendered a distinct service to botany by the publication of two historical papers in the *Journal of the Elisha Mitchell Scientific Society*, the first (April, 1910) entitled "A Visit to the Grave of Thomas Walter" and the second (July, 1911) "The Garden of Andre Michaux." Walter's grave is now in the midst of a dense forest growth in southern South Carolina, not far from the swamps of the Santee River, although when he was buried his grave was made in what had been his botanical garden. The flat stone over the grave tells us that he died "in the beginning of the year 1788." No traces of the garden remain. An old oak at the head of the stone is now heavily draped with *Tillandsia*. Here he lies alone in the dense wild shade of his forest-covered garden.

Michaux's garden was about ten miles from Charleston, but like that of Walters has become overgrown with a heavy forest growth of mostly native species, but undoubtedly some of the trees date from Michaux's time, and were probably planted by him.

THE same writer's report on "Science Teaching in North Carolina" (*N. C. High School Bull.*, July, 1911) contains some good suggestions in spite of the statement that the committee "has been unable to arrive at any general agreement" as to what the science work should be. However they agreed in one most important conclusion, namely, that where single courses in science are offered they "should include the most important facts and principles" of the sciences concerned, and this is commended especially for "students whose instruction is concluded with the high school."

IN the paper on "The Wilting Coefficient for Different Plants and its Indirect Determination" (*U. S. Dept. Agric. Bureau of Plant Industry, Bull.* 230) L. J. Briggs and H. L. Shantz attempt "to determine the extent of the variation exhibited by different plants with respect to the minimum point to which

they can reduce the moisture content of the soil before permanent wilting occurs," with the result that they conclude that the differences "are so small as to be of little practical utility from the standpoint of drought resistance." There is, however, a "great range in the wilting coefficient due to soil texture." The bulletin can not easily be summarized, and must be read by every botanist who is interested in physiological problems. The apparatus used is very ingeniously devised.

ALLIED to the foregoing is E. N. Transeau's paper on "Apparatus for the Study of Comparative Transpiration" in the July, 1911, number of the *Botanical Gazette*, in which he describes new forms of chronograph, weight droppers and irrigators, which he has devised and found useful.

Two recent ecological papers by R. M. Harper may be listed here, namely, "The River-bank Vegetation of the Lower Appalachicola, and a New Principle Illustrated Thereby" (*Torrey*, No. 11, 1911) and "The Relation of Climax Vegetation to Islands and Peninsulas" (*Bull. Torrey Bot. Club*, Dec., 1911).

AMONG recent economic papers are "The Propagation of Guayule by Seed," by Dr. J. E. Kirkwood (*Am. Review of Tropical Agriculture*, Vol. I.); "The Artificial Ripening of Persimmons," by Professor F. E. Lloyd (*Proc. Ala. State Hort. Society*, 1911); "American Medicinal Leaves and Herbs," by Alice Henkel (*U. S. Dept. Agric. Bureau of Plant Industry, Bull.* 219). The last named should interest the students in our schools of pharmacy.

THE "Annual Report of the Director of Forestry of the Philippine Islands" for the year ending June 30, 1911, contains much interesting matter for the botanist and general reader as well as for the professional forester. It is evident that there are serious forestry problems on the Islands not wholly unlike those that confront us in the United States, for the reckless destroyer is there just as he is here.

"The Forests of Oregon" (Bull. I., Oregon State Board of Forestry, 1911), by Professor G. W. Peavy, and the "First Annual Report of the State Forester" of Oregon (1912), by F. A. Elliott, indicate the state of mind of the people of the northwest in regard to the conservation of their forests.

ONE of the best of recent publications on trees is "New England Trees in Winter," by Professors Blakeslee and Jarvis, of the Storrs Agricultural Experiment Station (Bull. 69, 1911). After a helpful introduction, by means of keys the student is led to the principal genera, where further keys lead him to the species, and last to full descriptions accompanied by excellently selected photographs (in "half tone"). We do not recall any better treatment of our trees than is to be found in this publication, nor anything approaching it in other station bulletins. The authors are to be congratulated upon the quality of the matter which they have presented, and the Station upon its wisdom in giving it publication.

HERE may well be mentioned favorably E. R. Jackson's "Forestry in Nature Study" (U. S. Dept. Agric. Farmers' Bulletin, 468), which should be found in every public school in the country. Mr. Lamb's "Key to Common Kinds of Trees" (p. 38) should prove helpful to many teachers who have somewhat hazy ideas as to the identity of the trees about them. CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

THE ACCUMULATION OF OIL AND GAS IN SANDSTONE

LET two plates of glass be slightly inclined to each other and touching along one edge. Place by means of a pipette some petroleum and water between the plates. By manipulation of the plates, cause a bubble of air and oil to be enclosed within the water. It will be noticed that while the oil surrounds the air, much more than half of the oil will lie toward the thinner end of the combined bubble. This would, of course, naturally follow, since liquids are subject to capillarity and gases not.

Let us now consider the newly formed strata of marine or lagoon shales and sandstones, which are potentially petroliferous. All the interstices will at first be filled with water. Assuming now that the petroleum and natural gas arise from chemical changes in included organic substances, principally in the shale, we have the following sequence of events. The gas that originates finds itself forced by the greater hold that the water has for the fine interstices to take a position in the largest near interstice. If this is more globular than tubular or flat, a bubble of gas will be thus imprisoned, otherwise it will move along till it reaches the largest lacuna. In other words, much of the gas will leave finer grained rocks for the coarser, and so produce an accumulation of gas in sandstone reservoirs. Gas then is the first constituent to be forced into these reservoirs.

But further, although petroleum has a lower capillarity constant, it has an extraordinary capacity of spreading along a surface between water and a gas. This is shown by the way oil will surround a bubble of air in water between two plates of glass. Therefore, in the movement of the gas bubble from the place of origin to the reservoir, each will carry with it a pellicle of oil, and thus accomplish an accompanying movement of oil from the place of origin to the reservoir.

I regret that I have not the facilities to demonstrate experimentally these principles, since they would be easily put to the test, given the required apparatus.

As to their practical bearings,

(a) Since the shale can contribute to a neighboring sandstone reservoir, contiguous bodies of organic shale and limestones would be considered favorable circumstances, rather than negligible as held by I. C. White, who finds the origin of the oil and gas within the sandstone.

(b) A reservoir may be expected to receive its oil and gas from shale above as well as below.

(c) A sandstone embedded within shales that seem to have very little oil in them may

yet have derived its oil from them in the past. The oil has been largely moved away as formed. Hence, richly petroliferous shales are not a necessary indication in oil prospecting.

(d) Gravitational sorting requires not only a certain necessary degree of dip, but also a necessary degree of porosity, because in interstices below a certain size, surface tension checks the motion necessary for gravitational sorting. For this reason, water-filled shales or very fine-grained sandstones or limestones lying above porous rocks, act as impervious barriers, instead of allowing the oil and gas to reach the surface.

(e) While gas can move in a water-saturated rock with a lower degree of dip or with a lower porosity than oil, yet, since the gas bubble carries with it a pellicle of oil, a certain quantity of oil can be carried where it would not otherwise move.

(f) Inasmuch as all porous reservoirs in the strata constituting our oil fields were originally water-filled, dry porous sands really contain gas. It is not recognized because not under sufficient pressure to escape noticeably. This gas has been contributed to it generally by neighboring strata, and may have served for the transport of oil. As gas becomes more expensive, this gas may be extracted by suction, as is already done in gas-sands which have lost their pressure.

Of course, the principles here proposed are not exclusive of the action of gravitation and moving water, but act in conjunction therewith.

ROSSELL H. JOHNSON

BARTLESVILLE, OKLAHOMA

THE AMERICAN SOCIETY OF ZOOLOGISTS

THE Eastern and Central Branches of the American Society of Zoologists met in joint session at Princeton University, Princeton, N. J., December 27 and 29, 1911, in conjunction with the American Society of Naturalists and the American Association of Anatomists.

The following officers of the Eastern Branch for the ensuing year were elected:

President—A. G. Mayer, Carnegie Institution of Washington, D. C.

Vice-president—G. A. Drew, Marine Biological Laboratory, Woods Hole, Mass.

Secretary-treasurer—John H. Gerould, Dartmouth College, Hanover, N. H.

Additional Member of the Executive Committee—H. E. Jordan, University of Virginia.

These officers, in addition to David H. Tennent and Ross G. Harrison, will constitute the executive committee of the Eastern Branch. It is understood that the same officers of the Central Branch that served last year will continue in office.

The following persons were elected members of the American Society of Zoologists:

Central Branch—J. Frank Daniel, University of California; T. W. Galloway, James Milliken University; Wilhelmine Enteman Key, Lombard College; George R. La Rue, University of Michigan; Joseph A. Long, University of California; Marian L. Shorey, Milwaukee-Downer College; Aaron F. Shull, University of Michigan; Leroy D. Swingle, Nebraska Wesleyan University.

Eastern Branch—Thomas Barbour, Harvard University; M. T. Burrows, Cornell University Medical College; H. S. Colton, University of Pennsylvania; E. D. Congdon, Cornell University Medical College; Henry Fox, Ursinus College; Leland Griggs, Dartmouth College; Mary J. Hogue, Mt. Holyoke College; M. H. Jacobs, University of Pennsylvania; H. G. Kribs, University of Pennsylvania; C. V. Morrill, New York University and Bellevue Hospital Medical College; H. D. Reed, Cornell University; A. H. Wright, Cornell University.

The following committee was appointed to consider during the ensuing year the problem of the organization of the society, and to prepare a new constitution: H. V. Wilson, chairman; E. G. Conklin, G. A. Drew and R. G. Harrison (Eastern Branch); F. R. Lillie, W. A. Locy and M. M. Metcalf (Central Branch).

The following papers were presented at the meeting, either in full or by title:

The Sense of Smell in Necturus maculatus: R. E. SHELDON, University of Pittsburgh.

Conjugation and its Significance in the Ciliate, Didinium: S. O. MAST, Johns Hopkins University.

Didinia about to conjugate decrease nearly three fourths in size, and the anterior ends become considerably flattened. They find each other by random movements, join anterior end to anterior end and remain together from four to twelve hours or longer, depending largely upon the tem-

perature. The nuclear changes are similar to those found in *Paramecium*. A large percentage of exconjugants usually die, but sometimes all live. The proportion of fatalities is essentially the same in small individuals taken from the same culture but not allowed to conjugate, while large individuals nearly all live. There is no evidence indicating that there is any difference in the vitality of the two individuals of conjugating pairs foreshadowing sexual differentiation, as held by some investigators. The rate of fission is apparently not affected by conjugation, and if there is a rhythm in the rate of division, such as has been described for certain other infusoria, it is independent of conjugation as is shown by the following results. In seven closely related families under the same environmental conditions the rate of fission was practically the same during a period of several weeks, although the number of generations since conjugation at the close of the experiment varied in the different families from 123 to 553. Conjugation is almost invariably accompanied by encystment, *i. e.*, when certain individuals in a culture conjugate others encyst. This seems to indicate that conjugation, like encystment, functions in bridging over periods of unfavorable environmental conditions. Conjugation produces an increase in physiological variability; some of the exconjugants consequently have a better chance to survive under adverse conditions than do those which have not conjugated.

Behavior of Fire-flies (Photinus ardens?) with special Reference to the Problem of Orientation: S. O. MAST, Johns Hopkins University.

The fire-flies studied are found in dark crevices or under ground during the day. In the evening when it is still light enough to read they come out; the females crawl to the tips of grass or other objects and remain quiet; the males fly about and glow fairly regularly at intervals of about five seconds. The females do not glow unless light from the males or from some other source is flashed on them. When a female glows in response to the glow of a male, the male ordinarily turns directly toward her. This is repeated until the two come together, after which copulation takes place. There are no other factors involved in mating. If a female is held near a male he pays no attention to her unless there is actual contact, showing that neither objective vision nor smell is functional in mating. The males do not orient when exposed to continuous illumination. They respond only to flashes of light, and do not

react until after the light has disappeared. Thus orientation may take place in total darkness, and it is surprising how accurately these animals turn through the proper angle in the total absence of the stimulating agent that caused the response. Here we have a case in which it is clearly demonstrated that light does not act continuously in the process of orientation as demanded by Loeb's theories, a case in which it is also clearly demonstrated that continuous stimulation is not necessary to keep the organism oriented.

Experiments with the Influence of Darkness upon Pigment Development in Amphibian Larvae: A. M. BANTA, Station for Experimental Evolution.

From newly laid eggs series of *Amblystoma tigrinum* were reared (1) in darkness and (2) in ordinary laboratory light, and compared with those developing (3) in the pool where the eggs were laid. The amount of pigment developed in each individual of the different series was determined by means of color tops, and records were made in terms of the percentages of black, white, orange and yellow, which when blended matched the color of the animal's skin. For the salamanders on the average the body color of the series reared in darkness contained 49.7 per cent. black and 50.3 per cent. non-black (16.9 white, 9.3 orange and 24.1 yellow); the series reared in laboratory light averaged 86.1 black and 13.9 non-black (4.7 white, 2.4 orange and 6.8 yellow); and the series examined from the outdoor pool averaged 86.6 black and 13.4 non-black (4.5 white, 3.1 orange and 5.8 yellow). Hence the salamanders reared in darkness contained about four times as much non-black in the body color as those reared in daylight in the laboratory or in the outdoor pool where the eggs were laid. The darkest individual in the series reared in darkness, with 70.5 black, was much lighter than the lightest, with 82 black, of either of the series reared in the light.

To be published in full in *The American Naturalist*.

A Comparison of the Light Reactions of a Subterranean and an Epigeal Race of an Amphipod Species: A. M. BANTA, Station for Experimental Evolution.

The Spawning Habits of the Sea Lamprey, Petromyzon marinus: L. HUSSAKOF, American Museum of Natural History.

The observations were made on the Nissequogue River at Smithtown, Long Island, June 1 and 2,

1911, while collecting material for an exhibition group of *Petromyzon* for the American Museum. The nests are depressions in the gravel of the river-bottom, two to three feet in diameter, and six inches deep at the center. The method of their construction and the general behavior of the specimens on the nest are very similar to those of the Brook Lamprey. But owing to the large size of this species all its movements can be minutely observed.

To be published in full in *The American Naturalist*.

On the Factors that Determine the Location of the Borings of the Yellow-bellied Sapsucker on the Paper Birch: MARGARET W. TAGGART, University of Illinois. (Introduced by Jacob Reighard.)

The aim of the present study is to determine the details of the work of the yellow-bellied sapsucker (*Sphyrapicus varius varius*) upon the paper birch (*Betula alba paprifera*). The borings of the sapsucker on the birch are distributed in several separate areas on a single tree. These individual holes are arranged in definite rows: they are distinct, small, numerous and are rarely confluent. The birds as they excavate eat the sap and cambium of the tree and also the insects attracted by the liberated sap. The factors involved in an explanation of the distribution of the groups of holes and in the shape and arrangement of the individual borings are two—the woodpecker instinct to bore holes and the mechanical conditions under which the bird works. The mechanical conditions resolve themselves into: (1) The perching of the bird. The sapsucker perches on knots and rough places on the bark, rather than on the smooth bark, and uses the excavations it has made in preference to the knots, because they afford a firmer foothold. (2) The structure of the bark. The shape of individual holes and the arrangement of series of holes in vertical columns is determined by the structure of the bark. (3) The use of the cambium as an article of diet. A flow of sap is released by the use of the cambium as an article of diet. The sap attracts insects as a purely incidental result of the bird's work. (4) The cleaning up of all the cambium around the edges of the holes. The large denuded areas are formed as an accidental accompaniment to cleaning up all the cambium around the edges of the holes, and may or may not appear on a given tree. Any explanation, therefore, which involves instinct or intelligence, more

than the general woodpecker instinct to make small holes, is unnecessary. The external factors are an adequate explanation of the facts in the case.

Provisional Tabulation of Some Brain Collections with Special Reference to their Usefulness for Taxonomic Purposes: BURT G. WILDER, Cornell University.

The Brain of the New Goblin Shark: WILLIAM A. LOCY, Northwestern University.

Control by the Sympathetic Nervous System and its Morphological Basis: ALBERT KUNTZ, University of Iowa.

To be published in the *Journal of Comparative Neurology*.

Nervous and Non-nervous Responses of Actinians: G. H. PARKER, Harvard University.

A few seconds after a mechanical or a chemical stimulus has been applied to the ectoderm of the lower part of the column of a sea-anemone (*Metridium marginatum*), the animal will respond by contracting the longitudinal entodermic muscles of the mesenteries, whereby the oral disk becomes retracted and ultimately covered by the action of the ring-muscle. The fibrillar layer in the base of the ectoderm and entoderm, believed by the Hertwigs to be the nervous layer, does not offer an easy means of explaining this reaction, since it does not connect the ectoderm in any direct way with the longitudinal mesenteric muscles. Neither does this layer become stained or impregnated by any of the ordinary methods used for the demonstration of nerve-cells or neurofibrils. By a modified silver method devised by Dr. E. G. Titus, a rich system of neurofibrils can be demonstrated in the supporting lamella of the column. These fibrils penetrate the ectoderm and reach through the supporting lamella of the mesenteries to the longitudinal mesenteric muscles. They are the essential nervous elements in the retraction reflex just mentioned.

When a sea-anemone is cut nearly in two, nervous transmission from one piece to the other can be accomplished through almost any part of the body of the animal except the lips. Yet in the lips the so-called nervous layer of the Hertwigs is as well developed as in any other part of the body. This layer, therefore, probably is not the true nervous system; the true nervous system consists of the nervous elements imbedded in the supporting lamella. The layer described by the Hertwigs as nervous is composed of the fine basal branches of the epithelial cells and may be a mechanism for

the absorption of nourishment from the fluids of the intervening spaces.

If a mechanical stimulus is applied to the middle of the column of a *Metridium*, in somewhat less than a minute a well-marked constriction encircles the animal, due to the contraction of the circular muscles of the column. This constriction will occur on a column whose ectodermic surface has been anesthetized with magnesium sulphate to such an extent that the characteristic retraction reflex can not be called forth from it. It is therefore probably a non-nervous direct response of the muscle comparable to the direct responses already demonstrated in the muscles of some sponges.

The Structural Changes during the Contraction of Mollusk Muscle: ULRIC DAHLGREN, Princeton University.

The Organs of Equilibration in Pelecypod Mollusks: ULRIC DAHLGREN, Princeton University.

Preliminary Chemical Studies on Male and Female Producing Eggs of Pigeons: A Study of the Eggs of Forms in which the Dominance of Male and Female Sex and of White and Dark Color was Experimentally Determined by Professor C. O. Whitman: OSCAR RIDDLE, University of Chicago.

Much more important than the results of these preliminary chemical studies are the hitherto unannounced facts upon which the studies are based. One of the remarkable results achieved by Professor Whitman in his work with pigeons is the experimental control of the sex and color of the offspring of certain crosses of pigeons. That is to say, one and the same pair of birds can now be made to produce only dark male offspring—in spring and early summer, and when birds are young and in full reproductive vigor; and likewise only white female offspring—in late summer and autumn, and when birds are very old. The method consists simply in the choice of birds of known age and vigor for the matings, and then removing their eggs as fast as laid to other birds—thus forcing the birds throughout the year to their maximum of egg-production. All of the first several pairs of eggs produce dark male hybrids; while all of the last several pairs produce white female hybrids. A short transition period intervenes in which the sex and color of the progeny can not be foretold. There is usually a final period in which eggs are produced capable of little, and of no development. Birds thus treated over a period of years show that fewer and fewer

males are produced each succeeding year, and that the time of appearance of female-producing eggs is moved more and more toward the beginning of the season. Finally, matings of very old birds can be made in which it can be definitely foretold that only white female offspring will be produced. These results have been verified yearly since 1903. It is necessary of course to mate individuals of two different species, varieties or hybrids (one bird dark the other light if color is to be controlled) for such control. Four pure species (reciprocal crosses) and four different kinds of hybrids were successfully used in this way. Stated in Mendelian terms—terms which Professor Whitman did not think it well to use—he was able to shift, control or determine experimentally the dominance of sex and color. Aside from the fact that this discovery by Professor Whitman furnishes a starting point and a background for my chemical studies, it unfortunately seems necessary to emphasize at this time, that, although Professor Whitman had never announced this result, he had obtained it as early as 1903; and that this result—confidentially communicated—has been well known to his colleagues at the University of Chicago practically since that time.

The result of a limited number of parallel incubations and analyses made in 1911 on the male-producing and female-producing eggs obtained from the above-mentioned crosses indicate (number too small for final decision): (1) That eggs of smaller size, higher water content and smaller energy content (i. e., fewer units of physiologically available energy) can be correlated with maleness and dark color in the offspring. (2) That eggs of larger size, lower water content and greater energy content can be correlated with femaleness and white color in the offspring.

On a Relation Found to Exist between Changes in the Chemical Composition of a Membrane and Changes in its Permeability: OSCAR RIDDLE and ADELAIDE A. SPOHN, University of Chicago.

The follicular membrane can be taken for analysis at three different phases of its normal permeability to the constituents of yolk, viz: (1) When these constituents are penetrating the membrane very slowly; (2) when a sudden and very great increase in this rate of penetration occurs; and (3) the period following this increase and during which the greatly increased permeability is also accompanied by a rapid proliferation of the component cells of the membrane. Analyses show that in phase (1) when the permeability and

growth of this membrane are moderate in amount, the lecithin content of the membrane is of medium value (9 per cent.). At phase (2) the lecithin content is high (15–23 per cent.). During phase (3) the lecithin content again assumes a medium value (8.5 per cent.). The fat content is much lowest at phase (2) (=traces). In phases (1) and (3) this figure is 6 per cent. and 7 per cent., respectively. It has been shown that these values are not produced by variable amounts of contaminating yolk. The results seem to lend some support to Overton's theory of the lipid nature of the cell membrane; and indeed to indicate that that theory may be extended so as to apply to a *membrane of cells*. At any rate, here is one case where changes in degree of permeability of a *cellular membrane to substances rich in fat* (yolk) are preceded or accompanied by a change in the lecithin content of the component *cells*, of the membrane.

Some Chemical and Hybridization Experiments in Invertebrates: MAX MORSE, Trinity College.

A number of crosses were attempted at the Harpswell Laboratory, South Harpswell, Maine, between the nemertean, *Cerebratulus*, and various invertebrates, such as *Echinarachnius*, *Ilyanassa*, *Strongylocentrotus* and others, both by simple mixing of eggs and sperms and by the application of hypertonic solutions and other reagents known by previous experiments to cause polar bodies to form or even to induce the earlier morula divisions of the egg. Of the several crosses attempted, only one was in any degree successful, this being *Cerebratulus* egg by *Ilyanassa* sperm, the polar bodies being extruded and the earlier segmentations passed through. However, even here it was found impossible to prolong the growth of the embryo to gastrulation, although temperature, salinity, alkalinity and other factors were considered. The cross in question was checked against errors in manipulation, contamination, etc. No experiment made according to the methods of Godlewski, Kupelwieser, *et al.*, where excessive amounts of sperm were used, were successful, nor were experiments involving normal fertilization, preceded by or followed by hypertonic or other parthenogenetic reagents, successful in causing even polar bodies to form. Hence *Cerebratulus* is similar to several other forms where attempted hybridization was found to be futile.

A Comparison of the Retardation Produced by Rapid and Slow Electrons (Beta Radiations) of Radium in the Growth of Various Seedlings and a Consideration of the Relative Importance of

Chemical and Physical Factors in the Process: E. D. CONGDON, Cornell University Medical College.

The method of comparing the effect of the rapid and the slow electrons consisted in the exposure of one lot of dry seeds (*Synapis nigra*, *Panicum germanicum*, *Amaranthus monstrosus*, *Nicotiana tobacum* and *Papaver somniferum*) to rapid electrons and another lot to a like intensity of rapid electrons plus secondary slow electrons coming from a lead tube. Both sets showed a retardation which decreased in amount with shortened exposure. The slow electrons had one fourth as great ionizing power in the air as the rapid electrons. Their retarding effect, however, was much greater than one fourth that of the rapid. In one case it was twice as great. Therefore, when very small seeds are taken so that the non-penetrating electrons can distribute their effect through the whole seed, the slow electrons, relative to their ionizing power in the air, are much more biologically effective than the rapid. It was also found that absence of seed coat increased greatly the effect, not only of the slow (non-penetrating) but of the rapid (penetrating) electrons. The placing of the embryo side of the seed toward the radium had a like effect. Those seeds with the greatest diameter were least retarded, and *vice versa*. Thus even in such small organisms, the largest having a diameter of only 0.67 mm., factors governing absorption play a great rôle in determining their sensitiveness. To determine the importance of chemical make up, pairs of seeds of like diameters but very unlike constitution as to starch and fat were exposed. The testa had been removed and the embryos all turned toward the radium. The pairs of species having seeds of like diameters showed almost identical degrees of retardation. The differing sensitiveness of the species here used must then be referred to physical rather than chemical differences in the seeds.

Studies in Developmental Energetics. I. The Changes in Chemical Energy during the Development of Fundulus heteroclitus: OTTO GLASEB, University of Michigan.

Studies on the Artificial Production of Grafted and Multiple Embryos: A. J. GOLDFARB, College of the City of New York.

By a modification of the Herbst method of treating sea-urchin eggs, it was possible to produce either (1) fertilized eggs without their membranes, and with the blastomeres completely separated, (2) the same but with the blastomeres only partially

separated, (3) the loose union of one or more eggs or parts thereof, (4) the greater or less fusion of one and one half to sixteen or more eggs into one large complex.

Observations upon living and preserved materials clearly showed the nature of the subsequent history depended upon the nature of the union of the component eggs. When eggs or parts of eggs were either partially separated or brought in loose contact, the development of the component eggs was independent, showing no influence of the one upon the others. Two or more normal plutei resulted, either separate or welded together into twins. A very considerable number showed varying stages in the fusion and regulation whereby several blastulae or gastrulae were reorganized into one giant or irregular single blastula, gastrula or pluteus. These changes involved interesting regulatory processes in the skeleton, gut, size, shape, etc., of the individual eggs. They also showed an independent rate of development with a frequent dominance of one and the gradual reduction and disorganization of the other eggs in such a partially fused mass of eggs.

Common Atypical Embryos and the Diverse Methods by which they are Produced: A. J. GOLDFARB, College of the City of New York.

The Influence of Magnesium Chloride on the Fertilizing Potential of Spermatozoa: R. A. BUDINGTON, Oberlin College.

The sperm of *Arbacia punctulata* was used. This was treated for various lengths of time (5 to 80 minutes) with different solutions of MgCl in sea water; .1, .2, .3, .4, .5 and .6 gm. solutions were employed. Such sperm was then used in artificially fertilizing eggs of the same species, two questions being kept in mind, viz., (a) Will such sperm cause earlier cleavage of eggs than will normal sperm? (b) Will such sperm fertilize a larger percentage of eggs than will normal sperm? A positive result was obtained for the first problem when sperm were exposed to weak solutions for 5 to 15 minutes. As to the second problem, no marked increase in relative number of eggs fertilized, over the proportions shown by the control, could be detected.

The complete paper will probably be published in *The Biological Bulletin*.

The Effect of Narcotics upon the Development of the Hen's Egg: A. M. REESE, West Virginia University.

To be published in SCIENCE.

Effect of Commensal Plant Cells in Altering the Rate of Starvation in Scyphomedusæ: ALFRED G. MAYER, Carnegie Institution of Washington.

The scyphomedusa *Cassiopea xamachana*, of Tortugas, Florida, is infested with Zooxanthellæ, which when exposed to daylight operate through photo-synthesis to fix the carbon given off as a result of the medusa's metabolism, and at the same time to set oxygen free, thus serving as an efficient aid to the vital processes of the medusa. If the medusæ be maintained in darkness, the zooxanthellæ are rendered inactive, and the medusa starves more rapidly than if exposed to the diffuse light of the laboratory. In darkness the course of starvation is represented by the formula

$$y = W(1 - a)^x,$$

where y is the weight upon any day x after starving has begun, and W is the original weight when starving began. a is the index of starvation, for it increases as the rate of starvation increases. When the medusæ are starved in darkness, a ranges from .075 to .205, but in diffuse daylight it is less, varying from .046 to .15. When the medusæ are starved in diffuse daylight they lose weight more slowly than if in the dark, and the formula for starving in the light may be represented by

$$y = W(1 - a)^x + \Delta \left(\frac{w + w(1 + \beta - \theta)}{2} \right) \times [(1 - a)^{x-1} + (1 - a)^{x-2}(1 + \beta - \theta) + (1 - a)^{x-3}(1 + \beta - \theta)^2 + \text{etc.} \dots (1 - a)^{x-x}(1 + \beta - \theta)^{x-1}] + w(1 + \beta - \theta)^x,$$

where w is the original weight of plant cells in the medusa, β their coefficient of increase, θ their coefficient of mortality, and Δ the coefficient of assimilation of these cells by the medusa. The medusæ may be starved 41 days, and still remain alive when their weight has been reduced to one hundredth of its original mass. If starved in seawater which has been sterilized by heating to 72° C., and then cooled to normal temperatures, the medusæ lose weight about 1½ times more rap-

	Movements Cease at	Temperature of Greatest Activity	Movements Cease at	Death Occurs at
<i>Aurellia</i> from Tortugas	7° .75 to 11° .8 C.	About 28° C.	36° .4 to 38° .4	38° .5
<i>Aurellia</i> from Halifax, Nova Scotia.....	—1° .4	18° to 23°	29° to 29° .7	29° to 30°

idly than if starved in sea-water which has been passed through filter paper but not heated. This leads one to suspect that Pütter's "dissolved food" in sea-water may not be available unless some bacteria or other organisms be present in the sea-water to stimulate or maintain a synthesis of the inorganic ingredients of sea-water that may result in building up the animal body. In other words, sea-water as such may not be a nutrient fluid for animals unless acted upon by certain plant-like organisms in the immediate presence of the animal itself. As a side issue of this research, it appears that the so-called "converse relation between ciliary and muscular movements" in ctenophores, trochophores, veliger larvæ, etc., is not a chemical but merely a mechanical matter. When the muscles contract pressure is brought to bear upon the ciliated cells, and this renders them relatively insensitive to stimuli and the cilia stop; *vice versa* when the muscles relax, as under the influence of magnesium, the normal stretching of the cilia-bearing epithelium is reduced and the cilia are free to beat incessantly, as do isolated cilia-bearing cells when mechanically torn away from the epithelium and set free in the water.

This paper may appear in the forthcoming volumes of "Researches from the Tortugas Laboratory of the Carnegie Institution of Washington."

The Temperature Reactions of Medusæ Ranging from Temperate to Tropical Oceans: ALFRED G. MAYER, the Carnegie Institution of Washington.

In species of *Aurellia*, *Limulus* and *Pennaria* which range from cold to warm seas, it is found that individuals living in the tropics have a higher optimum and a higher death temperature than have those living in cold seas. Also the individuals in the tropics can not withstand such low temperatures as do individuals of the same species in cold seas. For example, consider the case of *Aurellia aurita*, the common scyphomedusa, which ranges from pole to pole and is found in all oceans: *Aurellia aurita* from Tortugas, Florida, is killed if frozen into the ice, but specimens from Halifax, Nova Scotia, survive this treatment.

A strictly tropical medusa, such as *Cassiopea frondosa* is killed at from 8° to 9° C., but it continues to pulsate up to about 38°-40° C. Evidently it could not survive in cold seas, and this may account for the fact that not a single species of *Cassiopea* has ever been found in the temperate regions. On the other hand, a form confined to arctic or cold seas, such as *Cyanea*

arctica from Halifax, Nova Scotia, pulsates until frozen into the ice, a treatment which causes it no apparent injury. On the other hand it is killed by 30° C. Thus it could not survive in the surface waters of the tropics and no *Cyanea* has yet been found in tropical waters. On the other hand the case of *Limulus* shows us that temperature resistance is by no means a sole factor in determining the geographical range of animals, for on the Massachusetts coast *Limulus* remains active from -1° to 41° C. and at the Marquesas Keys in Florida from 0.8° to 45° C. Yet it ranges only from Maine to Yucatan, and all attempts to introduce it upon the coast of Europe have failed.

This paper may appear in the forthcoming volume 5 of "Researches from the Tortugas Laboratory of the Carnegie Institution of Washington."

Symmetry in Regeneration: HERBERT W. RAND, Harvard University.

When a bilaterally symmetrical metazoan is bisected in a plane oblique to its long axis, regeneration, if it occurs, takes place in such manner that asymmetry, in the ordinary geometrical sense of that word, persists until regeneration is nearly or quite completed. The literature dealing with such experiments contains many descriptions which indicate or suggest that the new part, in the earlier stages of its regeneration, lacks, as regards form and organization, coordination with the old part; and that coordination of new and old parts to constitute a normal whole is secondarily effected by means of organogenetic and regulatory processes.

These descriptions give rise to misconceptions regarding the true nature of the regenerative process. A reinvestigation of regeneration from oblique surfaces in planarians reveals evidence that the new material is, from the very beginning of the regenerative process, in the highest degree coordinated with the old. While, during regeneration, the total material is asymmetrical in a geometrical sense, nevertheless a perfect organic symmetry exists in the sense that such materials and energies as are present are distributed upon either side of a morphological median surface (not a plane surface) with precise regard to a certain completeness of plan which remains to be worked out only in a quantitative way. This unity of organization certainly exists from the moment when the formation of new tissue begins—perhaps even before regeneration is outwardly manifested.

The Larva of Sarcophaga, a Parasite of Cistudo Carolina, and the Histology of its Respiratory Apparatus: WM. A. KEPNER, University of Virginia.

This *Sarcophaga* has only been observed three times. Packard discovered it first. He took it to be an *Cæstrid* larva. Wheeler later succeeded in raising imagines from the larvæ and found that the flies belonged to the genus *Sarcophaga*. A careful study of the larvæ taken from a *Cistudo Carolina* in Virginia also revealed that these were larvæ of a *Sarcophaga* and not those of an *Cæstrid*. The anterior stigmata are laterally compressed fan-shaped processes. Each stigma represents for the most part a proliferated mass of the two-layered cuticle of the general surface. At its wide free end the anterior stigma bears 16 to 18 finger-like papillæ. At the tip of each papilla there is a pore which opens into a branch of the lumen of the stigma. The lumen of this anterior stigma is filled with a finely reticulated plug of chitin. Just as the tænidia of the main trachea are given off by the inner, denser cuticular lining of the trachea so the reticulated plug is given off by the inner, denser layer of the cuticular substance of the anterior stigma. The larvæ spend three or four days in emerging from the skin of the host. It is inferred that during this time the anterior stigma are functional, and that the reticulated plugs act as bacterial screens for the two main tracheal trunks.

The complete paper will be published in the *Biological Bulletin*.

The Intra-uterine Embryo of the Bonnet-head Shark, Sphyrna tiburo: E. W. GUDGER, State Normal College, Greensboro, N. C.

This shark is viviparous, but viviparity is not attained by a villous uterus secreting a "milk" as in *Dasyatis* say and *Pteroplatea macrura*, two rays common on our Atlantic coast. The inner mucous lining of the uterus is separated from the outer muscular coat by a fibrous spongy material, hence considerable growth of the embryos may take place before any distension of the outer wall is necessary. The embryos in the fish captured measure 50 mm. in length. They lie nested in the cavity of the uterus, each in a separate spindle-shaped compartment or depression in the mucous lining. The embryos have a large number of external gill-filaments 15-18 mm. long protruding from the gill-slits. The umbilical cord is about 50 mm. long and is closely beset with what Alcock

has called "appendicula," large clear villi-like structures, sometimes single, sometimes forked. The yolk-sac is large and flat. Each egg with its embryo is contained within a very thin but tough and elastic membrane, highly iridescent in appearance. The ends of this shell are curiously plaited and folded and when unfolded the shell becomes of great length. The purpose of this seems to be to accommodate the growing embryo, since Alcock found the 18-inch young of *Zygæna blochii*, the Indian Hammer-head, still enclosed in the shell. The same authority reports that the emptied yolk-sac becomes adherent to the wall of the uterus and thus becomes a functional placenta. The embryos under consideration are too young to show anything of this kind. The function of the "appendicula" is not known. The data given are from a shark studied at the Beaufort, North Carolina, Laboratory of the United States Bureau of Fisheries.

This abstract represents a part of a paper on "Viviparity in Beaufort, N. C., Sharks and Rays," which will probably be published in the *Bulletin of the U. S. Bureau of Fisheries*.

Amitosis in Testes of Tænia Serrata: R. T. YOUNG, University of North Dakota.

Occasional evidence of amitosis is found in early stages of these organs, consisting in (1) cells which show distinct incisions of the cytoplasm, (2) cells with straight or nearly straight edges separated by narrow spaces, as though recently broken apart, and (3) bi-nucleate cells constricted between the nuclei.

Epithelium of Plathelminths: R. T. YOUNG, University of North Dakota.

To be published in the *Journal of Morphology*.
Some Uses of Celluloid in the Biological Laboratory: J. S. KINGSLEY, Tufts College.

Small skeletons like those of the frog and *Necturus*, bleached tests of sea-urchins, etc., are sure to be quickly destroyed by students unless protected in some way. For some years I have used boxes of glass, fastened together with paper or tape, for this purpose, but recently, acting on a hint from Dr. Gast, of the Naples Zoological Station, I have made the boxes of transparent sheet celluloid, sometimes with one side of glass. The celluloid is such as is employed for automobile wind-shields and comes in sheets measuring 20 by 36 inches. The thickness is accurately gauged and is in multiples of 5/1000 of an inch. I have mostly employed 10/1000 and 15/1000, the cost of the former being 75 cents, the latter \$1.00 a sheet.

The celluloid is cut with the shears to the required size and shape and the boxes are built by cementing the edges of the sheets by bringing them into the desired position and then moistening them with acetone applied with a small brush. Less than a minute is required for the firm adhesion of the edges. In the same way the celluloid can be fastened to the edges of a light of glass, provided that the edges of the latter be clean. Of course considerable care must be exercised to see that all pieces of celluloid be accurate in size. The details of the operations are not easily described, but a little experience will enable any one to devise methods to meet all cases. The specimen can be fastened to the glass or celluloid by means of scraps of the waste celluloid dissolved in acetone. I have now fluid specimens mounted in "Wilson's oil" and enclosed in boxes of celluloid, built up in the same manner, which have been in good condition for several months. How permanent they will prove, time can only decide. It is impossible to mount them in alcohol or formol as water or alcohol dissolve the camphor and other substances in the celluloid. In the case of Wilson's oil the box must be completely filled or there will be a warping of the celluloid which will break down the box in a few days. I believe that celluloid can be used to fasten the tops to the square museum jars, but I have not tried it. I may suggest that strips of celluloid be fastened to the ground edge of the jar by acetone, the jar be then filled as completely as possible with the preserving fluid without wetting the edge of the celluloid, and then the cover applied, acetone being run in with a brush, and then a solution of celluloid in acetone being painted over the joint. It seems probable that, with such a thin layer of celluloid, there would not be sufficient warping to break the joint. It is often desirable to mount rather thick microscopic objects under pressure. I have used the following process in thus mounting parapodia of annelids. Two narrow strips of sheet celluloid are placed on a slide in the desired position and are then cemented to the slide by running acetone under them. The object, properly cleared, is placed between the strips, and the cover-glass pressed down and fastened in position with acetone run under. In two or three minutes balsam or dammar is drawn under the cover by capillary attraction and the slide is permanently mounted. I may say that the sheet celluloid is to be had in every large city. I have bought my supplies of Willard and Willard, 65 Bedford Street, Boston. The scraps from other

operations may be used, instead of gun-cotton or celloidin, for section cutting, being dissolved in alcohol and ether in the customary manner.

Parasites of the Muskrat: F. D. BARKER, University of Nebraska.

On the Number of Known Species of Animals: H. S. PRATT, Haverford College.

The first enumeration of all the species of animals known to science was made by Linnæus in 1758. In the tenth edition of the "*Systema Naturæ*" he described 4,236 species, which were apportioned among the various larger groups (which are here given their modern names) as follows:

Mammals	183
Birds	444
Birds and Amphibians	181
Fishes	414
Tunicates	3
Bryozoa	35
Mollusks and Brachiopods	674
Crustaceans	89
Arachnids	78
Myriapods	16
Insects	1,936
Worms	41
Echinoderms	29
Cœlenterata	74
Sponges	11
Protozoa	28

About a hundred years later (1859) Agassiz and Bronn made the following enumeration:

Vertebrata	18,660
Mollusks	11,600
Crustaceans	1,500
Arachnids	2,000
Insects	90,000
Worms	1,600
Echinoderms	550
Cœlenterates	1,820
Sponges	290
Protozoa	1,510
	129,530

In Ludwig's revision of "*Leunis*," published in 1886, the numbers of species are given as follows:

Mammals	2,300
Birds	10,000
Reptiles	2,500
Amphibians	1,000
Fishes	9,000
Tunicates	300
Mollusks	21,320

Crustaceans	5,600
Arachnids	4,000
Myriapods	800
Insects	200,000
Worms	6,300
Echinoderms	2,370
Cœlenterates	3,000
Sponges	600
Protozoa	4,130
	273,220

An estimate of the number of living species known at the present time (1911) gives the following results:

Mammals	3,500
Birds	13,000
Reptiles	3,500
Amphibians	1,400
Fishes	13,000
Tunicates	1,300
Mollusks	61,000
Crustaceans	16,000
Arachnids	16,000
Myriapods	2,000
Insects	360,000
Annelids	4,000
Bryozoa	1,700
Rotifers	500
Nemathelminthes	1,500
Plathelminthes	5,000
Echinoderms	4,000
Cœlenterates	4,500
Sponges	2,500
Protozoa	8,000
	522,400

Some Changes in the Nerve Cells of the Bee during its Life Cycle: W. M. SMALLWOOD, C. G. ROGERS and RUTH L. PHILLIPS, Syracuse University.

Ecological Observations in British Guiana and Brazil: HENRY E. CRAMPTON, Columbia University. (Illustrated with lantern slides.)

An Early Human Cranium from Unterlesece near Trieste: HARRIS HAWTHORNE WILDER, Smith College.

A fragmentary human cranium was exhibited which was excavated during the past summer in a cave in the small Slavic village of Unterlesece, 15 kilometers east of Trieste, Austria. The cavern is a mere cleft, not offering sufficient headroom to allow one to stand, or even sit, except at the very end, and could not have served for a dwelling. The deposits, therefore, consist of the things that have washed in and lodged in the hollows of the floor. They consist mainly of the bones of Neo-

lithic animals, and a few Neolithic shards. This fragment was found, associated with a right ulna, and a small shard of crude workmanship, in a bottom layer of clay, and covered by a distinct layer of loess, with stone fragments from the roof, among which were imbedded bones of the ox, sheep, horse, etc., also many pieces of a human skeleton with worn teeth, as in the American aborigines. The results of the detailed anthropometric measurements, of which 37 were taken, conform closely to certain other ancient skulls of the *sapiens* species, especially those of Egisheim, Cannstatt, Brunn, I. (1885), and probably Tilbury and Sligo. While, however, these latter are pretty definitely Quaternary (Solutrean, Magdalenian), this specimen, as dated by the shard and the general character of the remains in the cavern, must be either Neolithic or Transneolithic (Campignyan, Tardenoisian).

Evidence of Evolution in the Mechanism of Inheritance: MAYNARD M. METCALF, Oberlin College.

In some, perhaps in all, of the higher animals and plants the chromatin consists of discrete particles of different functions in physiologic activity and inheritance. These particles are grouped into chromosomes in which, in some species—perhaps in all—they form linear aggregates. There is an elaborate achromatic mechanism of mitosis which aids in securing the distribution of halves (?) of each discrete particle of chromatin to each of the two daughter nuclei. In many plasmodrome protozoa (perhaps in some stage of their life history in all of them) the nucleus contains a caryosome with a definite caryole and an outer membrane delimiting it from the peripheral zone of the nucleus. New granules of chromatin continually form in the caryosome (apparently at the caryole), wander to the caryosome membrane, after a time break through this into the peripheral zone of the nucleus, through which they migrate to reach the caryotheca. Many of these granules in time break through the caryotheca into the cytoplasm as chromidia, there to be dissolved. Apparently any of the granules so formed in the nucleus may become chromidia. The most careful study of these nuclei shows no indication of division of the chromatin granules within the nucleus during this formation of chromidia. Whole granules seem to be thrown off. Such a condition seems incompatible with the existence of a series of "determiners" in the nuclei of plasmodroma. The chromatin seems rather more homogeneous, each particle having the

same physiologic and inheritance value as every other except perhaps for size or density. This condition parallels the general physiological condition in the plasmodium whose protoplasm shows little differentiation for sensation, conduction, locomotion or specialized secretory activities, each bit of the protoplasm sharing in all these activities. In other protozoa we find several different types of more highly evolved chromatin structure. Some of these, as in *Opalina*, seem not in the line of evolution of the metazoan condition. Others, as in *Paramecium*, have chromosomes which are linear aggregates of granules and which split longitudinally in mitosis. Such a form has a chromatin arrangement which would allow differentiation of the granules into divergent determiners, for a portion of each granule is given in mitosis to each daughter nucleus.

A further discussion of this subject is in preparation. Its place of publication is not yet determined.

Opalina mitotica: MAYNARD M. METCALF, Oberlin College.

This paper, which was read by title only, will soon appear in full in one of the Spengel Festschrift volumes of the *Zoologischer Jahrbücher*.

The Pædogamous Conjugation of Blepharisma: GARY N. CALKINS, Columbia University.

There is some question as to the specific name of the organism with which I am working. Up to the present I have followed Butschli in calling it *B. musculus*, identifying it with the form *Urostyla musculus* described by Ehrenberg. The name *Blepharisma* goes back only to Perty in 1849, who first used it as a generic name for a species of *Spirostomum* described by Ehrenberg again, as *Spirostomum lateritia*. Leaving for the present the taxonomic position of the organism I wish to speak here more particularly of some of the biological phenomena which have come under observation during the five months that I have kept *Blepharisma* under culture. I isolated a specimen in July from pond water at Woods Hole and found that it lends itself readily to cultivation upon artificial media. For the best results a few drops of pond water plus a drop of 24-hour standard hay infusion are now used, a medium upon which the organisms have reached to-day the 160th generation. None of the earlier observers made out a micronucleus and from total preparations alone I was unable to demonstrate it. Upon study of sections of the organisms, however, I have been able to find structures which undoubtedly correspond

with a micronucleus in the typical ciliate. The macronucleus is large and comparatively easy to demonstrate, although it has a variety of forms; sometimes it is a single body of spheroidal form, again it breaks up into irregular fragments. On division there are two chief portions, one at either end, and a connecting strand of somewhat different texture and the micronuclei are connected with this. It is the custom of all who carry on careful culture work to isolate one individual and supply it with fresh medium every day. The individuals left over after isolation of the one specimen are placed in larger vessels and kept as "stock." Early in the summer it was seen that endogamous conjugations occurred frequently in this stock material, in some cases reaching the proportions of a general epidemic. So keen at times is this "sexual hunger" as Maupas called it, that conjugation occurs between the closest related cells. For example an individual was isolated in the 104th generation, fresh medium and food being given as usual. On the following day it had divided, but the two sister cells were united in typical conjugation. This, I believe, is the closest relation on record for pædogamous conjugants amongst Infusoria. The cells begin to conjugate at the anterior tips as in *Paramecium* and gradual fusion extends along the peristome for about two thirds of the length and never further, thus leaving the greater portion of the undulating membrane and the mouth entirely free. They remain in conjugation from 12 to 24 hours and separate through vacuolization of the connecting zone of protoplasm. The most remarkable phenomena are connected with the nuclear relations during conjugation on which I can now give only fragmentary notes, as my observations are not completed. The macronucleus becomes compact and spheroidal with a typical "kernspalt" in the center. It is also enclosed in a firm resistant membrane like a cyst, a structure which does not exist at other times. Sections of conjugating pairs show that the nucleus is made up at this time of two main bodies of chromatin of densely granular appearance, while between them long drawn-out rods of chromatin like chromosomes appear to be dividing. This central material gives rise to two smaller nuclei which are freed from the mass of macronuclear material and in the cytoplasm undergo one or two further divisions which result in the gametic nuclei. I have not yet found the pronuclei in the process of fusion, but have seen them in the connecting bridge between the

two organisms. Here then is something entirely novel in the make-up of macro- and micronuclei, the micronucleus being absorbed and protected by the macronucleus. The size statistics of conjugating and non-conjugating forms are similar in essence to those of *Paramecium*. Miss Watters has measured some 1,580 specimens, of which 482 were conjugating. The average size of the conjugants is 110 μ , of non-conjugants 140 μ , the latter including exconjugants which never regain normal size. More than 150 exconjugants have been isolated and maintained from time to time. Not one has lived more than 16 days, the dates being 22 per cent. dead on first day, 31 per cent. on second, 13 per cent. on third and 8 per cent. on fourth, with the rest scattering one or two per day until the sixteenth. This is similar to Bütschli's results with *Blepharisma* in 1876, when all of the ex-conjugants died within three days after separating. Vitality therefore is not restored by conjugation under the conditions of the experiments; whether it is due to these conditions, due to the paedogamic nature, or due to some other cause remains to be shown.

It is expected that this paper will be published in full in the *Journal of Morphology*.

Actinobolus radians St. and its Cultivation: GARY N. CALKINS, Columbia University.

Regeneration in Paramecium caudatum: FLORENCE PEEBLES, Bryn Mawr College.

The results of a series of experiments on *Paramecium caudatum* show that the power of regeneration varies greatly in different races, and also in individuals of the same race. It usually depends on the condition of the protoplasm, or the age of the individual at the time of the operation. The removal of the anterior one third causes greater disturbance in the cell than the removal of the posterior end. The fragment which is removed always dies, but the larger nucleated piece either regenerates the lost end or divides without regeneration into a normal and an abnormal individual. Regeneration of the anterior end took place in forty per cent. of the cells, while the posterior end regenerated in sixty-three per cent. Cells in the vegetative condition when cut in half form no abnormal individuals. One half dies and the other produces a normal one. It was found impossible by removal of the protoplasm to produce a small race from a large one. After several generations the normal size was restored. Vegetative cells seem to have much division energy stored up within them. Experiments indicate that three

division planes are present, so that one cell represents four individuals. The removal of a part of the protoplasm acts as a stimulus, and several divisions follow in quick succession. It was found impossible to cut the macronucleus in vegetative cells so that each fragment contained a part of it. When cells were cut in half during division both pieces received a fragment of the nucleus and formed normal races.

It is expected that this paper will be published in full in the *Biological Bulletin*.

Observations on Synapsis and Reduction: EDMUND B. WILSON, Columbia University.

The maturation-phenomena in *Tomopteris* and *Batrachoseps* have been reexamined by a study of the original preparations of the Schreiners and of Janssens, as well as of new preparations of *Batrachoseps* fixed and stained by various methods. This study has led to a confirmation of the main conclusions of the above-named observers in regard to synapsis. The seriation of the stages is placed beyond doubt by the conditions seen in *Batrachoseps*. In both this form and *Tomopteris* the facts seem to admit of no other interpretation than that the "amphitene" or synaptic stage represents a progressive union of leptotene threads, two by two and side by side (parasynapsis), to form pachytene loops of the haploid number; and in the case of *Batrachoseps* there is considerable evidence that this process is accompanied by a close torsion or twisting together of the leptotene threads as they unite. This process proceeds from one pole of the nucleus towards the opposite pole. In the opinion of the author it is impossible to admit the interpretation of this process offered by Fick, Goldschmidt, Hæcker and Meves that it is only a modified form of longitudinal splitting. Observations on the Orthoptera (grasshoppers) indicate that a similar mode of synapsis occurs in these animals, though it is less certainly shown than in the other forms. In the pachytene loops resulting from synapsis all traces of duality are usually lost to view, at least for a time. This may be due either to a close twisting together of the leptotene threads or to an actual process of fusion. In either case there is as yet no satisfactory evidence that the plane of the ensuing "reduction-division" is identical with that of the original conjugation. The facts point on the whole to the conclusion that the period following synapsis is one of reorganization of the chromosomes in which a redistribution of their substance may take place. This may be effected by a process of torsion as the chromo-

somes unite, or subsequently, followed by a new longitudinal split in a new plane, as suggested by Janssens in his theory of the chiasmotype. The conception of the "reduction-division" is however valid, since this division reduces the valence of the bivalent to one half, and it fails to take place in the case of univalent chromosomes, as is proved by the history of the sex-chromosomes, *m*-chromosomes and supernumerary chromosomes in the Hemiptera. The explanation of the Mendelian disjunction may be sought in either maturation-division or in both, as has been shown by Janssens.

The Penetration of the Spermatozoon and the Origin of the Sperm Aster in the Egg of Nereis:
FRANK R. LILLIE, University of Chicago.

(1) As described in a previous paper,¹ the egg of *Nereis* secretes a large quantity of jelly, derived from spherules of a cortical layer, immediately after contact of the spermatozoon. The perforatorium of the spermatozoon penetrates the vitelline membrane and becomes inserted in a well-marked entrance cone. *Fixation granules*, undoubtedly derived from the spermatozoon, appear at the tip of the perforatorium in the cone. The substance of the cone becomes differentiated by staining reaction and behavior to form an organ definitely concerned in the subsequent penetration of the spermatozoon. (2) The spermatozoon remains external to the egg embedded in the jelly for 45 to 50 minutes after attachment. The head is then drawn by the cone through the vitelline membrane into the egg in the form of a thick strand of chromatin several times the length of the original head of the spermatozoon. *The middle piece and tail remain external*, and may be seen on the vitelline membrane up to the time of cleavage. They never enter. (3) The chromatic thread representing the head of the spermatozoon then contracts to form a vesicular nucleus, still attached by the perforatorium to the cone. Nucleus and cone then rotate through 180° and the sperm aster arises always at the point of the nucleus farthest from the cone, thus in the position of the base of the sperm head. The problem of the origin of the sperm centrosome in the egg is considered in the next abstract. (4) The "fixation granules" are possibly cytoplasmic elements introduced by the spermatozoon, though they come from the apex of the spermatozoon. No other demonstrable cytoplasmic elements are introduced by the spermatozoon. (5) After origin of the aster the sperm nucleus separates from the cone, and the latter

gradually disintegrates in the cytoplasm. The sperm amphiaster becomes the cleavage amphiaster.

On the Fertilizing Power of Portions of the Spermatozoon: FRANK R. LILLIE.

If unsegmented eggs of *Nereis* be centrifuged about 60 revolutions of the hematocrit of the Bausch and Lomb hand centrifuge in about 40 seconds, thirty to forty minutes after insemination, the mass of eggs accumulates at the distal end of the tubes and becomes pressed together. The jelly, which is of less specific gravity than the eggs, then separates from the latter and forms a layer above the eggs. In squeezing through the narrow interstices between the closely packed eggs it rubs over the surface of each egg, and in many cases it carries the attached spermatozoon away with it. In other cases, especially if the eggs are centrifuged shortly before the time of penetration of the spermatozoon, it draws out the substance of the head of the spermatozoon, which is very ductile at this time, into a strand; and in numerous cases it carries away the tail and middle piece, or variable portions of the head in addition. Partial sperm-heads of all sizes are therefore left attached to the egg by the perforatorium. Such partial sperm-heads then penetrate, being drawn in by the entrance cone as in the case of normal fertilization, and they form partial sperm-nuclei attached to the entrance cone within the egg. Rotation then takes place and an aster invariably arises in connection with the partial sperm-nucleus at the point most distant from the cone, *i. e.*, at the most basal point of the sperm-nucleus. By using large quantities of eggs and by preserving at various stages one can study all stages of these processes in sections, and the above statements are based upon large numbers of observations. It is therefore proved (1) that the sperm centrosome is inessential for formation of the sperm aster within the egg; (2) the origin of the sperm aster is a nucleocytoplasmic reaction; (3) the sperm-nucleus is polarized with reference to this reaction inasmuch as the sperm aster arises always at the most basal point of the partial sperm-nucleus, with reference to the orientation of the nucleus in the sperm head. The conclusion therefore involves the conception of a certain differentiation between egg-nucleus and sperm-nucleus, for the former has no independent capacity of initiating karyokinetic phenomena, whereas the latter has.

The two preceding papers will be published in full in the *Journal of Experimental Zoology*.

¹ *Jour. Morph.*, 22, 1911.

Human Spermatogenesis: T. H. MONTGOMERY, JR., University of Pennsylvania.

The point was made that in man there are four types of probable functional spermatozoa, differing in their content of modified chromosomes. One type has two of these bodies, one has none, one has the larger body only and the other has the smaller only. All primary spermatocytes contain each one larger and one smaller modified chromosome. Further, during the histogenesis of the sperm the cuff of the spermatid is produced from nuclear sap, not from the cytoplasm, and since this cuff substance is thrown away with the abstricted cytoplasm the spermatid loses the greater amount of its nuclear sap. Therefore, this nuclear sap substance can not have the same value in inheritance as the other substances of the nucleus.

To be published in full in the *Journal of the Academy of Natural Sciences of Philadelphia, Centenary Volume*.

The X-element in Guinea-chicken Hybrids:

MICHAEL F. GUYER, University of Wisconsin.

The hybrids in question, all male, were the offspring of a black langshan cock and a common guinea hen. The X-element of the chicken is very large, of stout build and typically of different shape from that of the guinea. While each usually appears as a curved body, the X-element of the chicken is U- or bean-shaped with both ends of the same size, while that of the guinea is more comma- or pistol-shaped, with one end noticeably narrower than the other. The X-element of the hybrid was found to be invariably of the maternal (guinea) species type. In this fact may lie a simple explanation of why these hybrids were all male. For in all known cases it is the spermatozoon without the large X-element which unites with the egg in the production of the new male, and since such a spermatozoon is much smaller than one of the other type, this mere difference in size may be the factor determining which shall fertilize the egg. Hybrids are obtained with difficulty even under the most favorable conditions and we may reasonably suppose that the egg-plasm is more or less resistant or antagonistic to the entrance of a foreign sperm. If such is the case it would seem not improbable that the smaller type of spermatozoon with its diminished quantity of incompatible substance and its lessened surface against which resistance could operate, would penetrate more readily than the other, with the consequent production of a male.

To appear in full in *Journal of Morphology*.

Eight Factors that Show Sex-linked Inheritance in Drosophila: T. H. MORGAN, Columbia University.

Eight factors that show sex-linked inheritance have appeared in cultures of the fruit fly, *Drosophila*. These factors without exception follow in their heredity the distribution of the sex-chromosomes with which they may be said to be linked. (1) The red eye of the wild fly is due to three factors—vermillion *V*, pink *P* and orange *O*. Of these *V* is not sex-linked, while *P* and *O* follow the sex-chromosomes. The red eye may be designated by *VPO*, the pink eye by *vPO*, the vermillion eye by *VpO* and the orange eye by *vpO*. Orange is present in all these cases, but since like *P* it is sex-linked (see below), it occurs in duplex in all females and in simplex in all males. The heredity of these eye colors has recently been published.² (2) A new color has more recently appeared, due to the loss of the orange factor. The formula for this mutant seems to be *VPo*. The females have darker eyes than the males; thus giving a dimorphic race. The *O* factor proves to be sex-linked. It will now be possible, unless associative inheritance interferes, to produce a new series of reds, vermilions and pinks that lack orange; and an eye that lacks all color determiners, but contains the color producer *C*. (3) White-eyed mutants due to the loss of the color producer *C* have been described,³ and these may carry the determiners for vermillion, pink or orange, etc. (4) The gray color of the wings of the wild fly is due to three factors—black *B*, yellow *Y* and brown *Br*. The formula for the wild fly is *BYBr*; for the black fly *ByBr*; for the yellow fly *bYBr*, and for the brown fly *byBr*. Of these three factors black, *B*, is sex-limited; yellow, *Y*, is not; and *Br* has not yet dropped out, so that its distribution is unknown. (5 and 6) Two wing mutants, described as rudimentary wings and miniature wings, both show sex-linked inheritance.⁴ The miniature wing is due to the loss of a factor *S*; its formula is *Ms*. The rudimentary or "short" wing is *Sm*. When a miniature female is crossed with a short male, all the females (*Ms Sm*) have long wings; all the males (*Ms..*) have miniature wings. When the "short" female is crossed to the wild male all the females (*Sm SM*) have long wings, and the few males that appear have short wings. The females are to the

² *Jour. Exp. Zool.*, 1911.

³ *SCIENCE*, 1910.

⁴ *SCIENCE*, 1911.

males as three hundred and eighty-one to three (381:3). (7) The bands on the abdomen, so conspicuous a feature of the normal fly, have been lost in another mutant. The factor is dominant and sex-linked.⁵ (8) Another wing mutant has appeared in which the second inner vein fails to reach the margin, often producing a bifid wing, but the shape of the wing is varied. The wings are held out at right angles to the sides of the body. The factor responsible for this condition is also sex-linked. Thus bifid-winged females crossed with wild males give all normal-winged females and bifid-winged males. The reciprocal cross gives normal-winged females and males and bifid-winged males.

Supernumerary Chromosomes and Conjugation of Chromosomes in Ceuthophilus (Sp.?): N. M. STEVENS, Bryn Mawr College.

The usual number of chromosomes in the spermatocytes of the first order is 19, eighteen bivalents and the univalent *X* chromosome. In one individual two supernumeraries, and in another one were found. These supernumerary chromosomes behave like those in *Diabrotica soror* and *D. 12-punctata*, dividing sometimes in the first, sometimes in the second maturation mitosis; and they probably originate, as in the *Diabroticas*, in an abnormal division of the *X* chromosome. In *Ceuthophilus* synopsis or conjugation of the chromosomes takes the form of parasynapsis. The chromatin threads pair side by side, twist together and in the prophase untwist. The homologous members of each pair unite end to end, forming compound rods, crosses or E-shaped figures, or they may unite by both ends, forming rings. The first maturation mitosis is a segregation division, the second equational. There is no synizesis stage, and no marked polarization of the chromosomes to form a bouquet stage.

This paper will be published in full in the *Biological Bulletin*.

Chromosome Studies: F. PAYNE, Indiana University.

A continued study of the *Reduviidae* throws no further light upon the origin of the irregular chromosome distribution found in that family. In *Psirontis*, however, is found a type of distribution new to the family and similar to that of *Gelastocoris oculatus*. In *Pselliodes*, which gives another type similar to that of *Prionidus* and *Sinea*, the single chromosome, the homologue of the small

idiochromosome, contains a larger quantity of chromatin than the three small chromosomes which go to the opposite pole. In this respect it is similar to the case of *Acholla*. A study of the ovaries of *Gelastocoris* reveals a nucleolus which forms shortly after the last oögonial division and remains until about the time of synapsis. In most cases this nucleolus stains uniformly, but in favorable places darker bodies can be seen within it. It seems probable that these darker bodies are the idiochromosomes, eight in number. In these ovaries the ova can be traced with unbroken continuity from the end chamber to the fully developed eggs.

To be published in full either in the *Journal of Morphology* or in the *Biological Bulletin*.

The Histogenesis of the So-called Apyrene Spermatozoa in Strombus: EDWIN E. REINKE, Princeton University.

The apyrene spermatozoon of *Strombus*, as compared with the eupyrene or ordinary spermatozoon, of this species, is a very large cell with a complex structure. The cell-body is cylindrical and tapering in shape and it is filled with many polygonal bodies which are undoubtedly composed of albumen. These bodies are very regular in outline and are arranged in rows; they vary considerably in size, those in the middle of the cell being larger than those at either end. The breadth of the cell is greatly increased by the presence of two undulating membranes which pass down either side of the cell and meet at the posterior end, where they are drawn out into a long sharply pointed tail-piece. Anteriorly these membranes fuse in the mid-line and give a broad, rounded appearance to this end of the cell. At the very tip, where the membranes meet, there is a darkly-staining cap; this is a centrosomal structure. Lying scattered through the cell and between some of the albuminous bodies are fragments of greatly degenerated nuclear material. The entire length of the spermatozoon is about 90 micra. The apyrene spermatozoa are found to originate from certain large pear-shaped cells which are attached by their narrow ends to the cyst-wall of the testis. These cells are easily recognized and can readily be distinguished from the eupyrene spermatocytes, not only by their size, but also by the presence of a large sphere with strong astral rays. The development of the apyrene spermatozoa from these cells is direct, that is, no cell-division occurs during their histogenesis; the nucleus simply breaks down, scattering nuclear fragments throughout the cell. These fragments immediately begin to degen-

⁵ *Proc. Soc. Exp. Biol. and Med.*, 1911.

erate and play no further active part in either the developing or the adult spermatozoon. At the time of the breaking down of the nucleus, the large sphere with its astral system disappears, leaving only the contained centrioles and a mitochondrial mass which surrounded it. There are a great many of these centrioles and, lying close together at the periphery of the cell, they very soon divide and one half of the resulting granules begin to move across the cell. In this way a large bundle of very thick axial fibers is formed and its subsequent growth greatly increases the length of the cell. Before it has reached its full growth, however, the bundle splits down its long axis. Continued growth greatly increases each half of the bundle to pass to opposite sides of the cell. Here, by fusing and pushing out the cell wall, they eventually form the undulating membranes. The albuminous bodies first appear a short time before the bundle of axial fibers begins to split. They are formed by the filling up with albumen of previously existing vacuoles. At first these bodies are spherical, but later, through crowding, they become polygonal. The foregoing facts, relative to the development and the adult structure of these cells, would indicate that their function, if any exists, must be widely different from that of the ordinary spermatozoa. Indeed, the evidence at hand is almost strong enough to make the application here of the word spermatozoon, in its specialized meaning, a misnomer.

Reinvigoration Produced by Cross Fertilization in Hydatina senta: DAVID D. WHITNEY, Wesleyan University.

A report of experiments was given in which Dr. Whitney has reared rotifers for five hundred generations by the parthenogenetic method. The females of each generation laid eggs and these at once without fertilization by a male grew into females for the succeeding generation. Dr. Whitney observed two long experiments for about three years and found that these animals gradually became weaker and weaker by this maleless method of reproduction and finally died out from general weakness if the experiments were carried on long enough. One of the races lived for 385 generations and the other is still alive in the 503d generation, but is in a very weak condition. When both races were alive and had reached a weakened condition males were produced from them and some inbreeding experiments were made in which eggs were fertilized by the sperm of the males of the same race. This was done in order to deter-

mine whether fertilization would bring the race back to normal vigor. Several successive inbreeding experiments were made and only resulted in a slight amount of reinvigoration of either race. However, when the two weak races were crossed a great amount of reinvigoration occurred at once and the resulting race was as vigorous as any young normal race.

To be published in full in the *Journal of Experimental Zoology*.

External Agents and the Growth Period of the Egg in Hydatina senta: A. F. SHULL, University of Michigan.

It is not possible to reduce the proportion of male-producers in this species of rotifer by transferring to manure solution eggs that have been laid in spring water, even though the manure solution is strong enough to exclude male-producers when the rotifers are bred continuously in it. The nature of the females is determined, therefore, before they hatch. A female that has already produced some male-producers, ceases almost immediately to yield male-producers if she is placed in manure solution. A female that has produced part of her family (all female-producers) in manure solution, may commence to bring forth male-producers almost immediately if she is transferred to spring water. The kind of female which will hatch from an egg is determined, therefore, within a period of two or three hours before the egg is laid. This period includes the entire growth of the egg and the formation of the single polar spindle.

The complete paper will appear in the *Journal of Experimental Zoology*.

Notes on the Inheritance of Barring: H. D. GOODALE, Station for Experimental Evolution.

Some Reactions of Drosophila to Parallel Rays of Light: H. G. KRIEBS, University of Pennsylvania.

The *Drosophila* were placed in a tube 8 inches long and about $1\frac{1}{2}$ inches in diameter. When placed in the light with the axis of the tube parallel with the rays no characteristic reaction could be observed. When the axis of the tube was tilted to an angle of about 45 degrees to that of the rays the flies at once showed their characteristic orientation. When, however, the ommatidia forming the central mass of the eye were painted over, the flies no longer reacted in the normal way when the axis of the tube was placed at the 45-degree angle, but would do so when it was placed parallel to the rays of light.

The following communication from a member of the society was received by the secretary too late for presentation at the Princeton meeting:

A Peculiar Structure in the Embryo of the Honey Bee: JAS. A. NELSON, U. S. Department of Agriculture.

In embryos from fertilized eggs of the honey bee, at the time when the germ layers are forming, but before the lateral folds have begun to unite, a small lenticular mass appears on the dorsal side of the egg, close to the cephalic pole. Its outer surface is almost plane, its inner strongly convex and studded with numerous delicate processes which join with the protoplasmic meshwork of the interior of the egg. This mass, which will be termed provisionally the cephalo-dorsal disk, appears to be a syncytium, composed of rather clear and vacuolated cytoplasm, within the inner half of which numerous nuclei are embedded. It lies at the surface of the egg and is continuous at its edges with the surrounding blastoderm. This structure was first noticed in 1904 by O. Dickel, who called it the "yolk plug." Dickel identified the point in the blastoderm where it first appeared as the blastopore, described the disk as formed by the migration of yolk cells to this point, and sought to connect it with the rudiments of the mesenteron, in an endeavor to interpret the process as gastrulation. A study of the antero-dorsal disk in sections of eggs of various ages shows: (1) that the so-called yolk plug does not arise from yolk cells, but from the blastoderm of the dorsal side of the egg by a cephalad migration of its cells and their aggregation at this point; (2) that at no time has the cephalo-dorsal disk any connection with the rudiments of the mid-intestine; (3) that during the stages immediately following the formation of the germ layers it becomes broken up into amœboid cells which wander off into the yolk at the cephalic end of the embryo. It therefore appears to be a center of distribution for cells from the blastoderm to the yolk. Its homologies are obscure, although Hirschler (1908) has described a somewhat similar structure which he called the "dorsal organ," in the egg of the chrysomelid beetle *Donacia*. It is also interesting to note that the cephalo-dorsal disk has, in its position, time of appearance and structure a very close resemblance to the cell mass described by Petrunkevitch in the drone egg as derived from the polar bodies and later forming the male sex cells.

The following exhibits were made during the meeting of the society:

An Early Human Cranium: H. H. WILDER, Smith College.

Microscopical Preparations of Epithelium of Plathelminths: R. T. YOUNG, University of North Dakota.

Microscopical Preparations to Show Amitosis in the Testis of Tania serrata: R. T. YOUNG, University of North Dakota.

JOHN H. GEROULD,
Secretary

DARTMOUTH COLLEGE

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

THE fourth annual meeting of the American Institute of Chemical Engineers was held in Washington, D. C., December 20-23.

The reports of the various officers for the year were read, and a very gratifying growth in membership was shown. New officers for the year were elected as follows:

President—Dr. L. H. Baekeland. *Second Vice-president*—Dr. T. B. Wagner. *Third Vice-president*—Professor M. C. Whitaker; the first vice-president being Dr. Eugene Haanel. *Treasurer*—Dr. F. W. Frerichs. *Secretary*—Dr. John C. Olsen. *Auditor*—Mr. G. W. Thompson. *Directors*—Messrs. A. C. Langmuir, H. S. Miner and A. Bement.

The following papers were read at the Wednesday morning session:

"The Hardening of Plasters and Cements and a Simple Chronographic Apparatus for Recording Set," Dr. Chas. F. McKenna. A very ingenious as well as simple instrument for measuring and recording this important property of cements was shown and explained by Dr. McKenna.

"Advances in Testing Explosives," Clarence Hall.

"Distribution of Power in Portland Cement Manufacture," Richard K. Meade.

"Problems in the Manufacture of C.P. Acids," J. T. Baker.

"Combustion of Pulverized Coal," L. S. Hughes.

"Manufacture of Gelatin," Ludwig Thiele.

During the afternoon the institute visited the Bureau of Standards and inspected the standardization of weights and measures, adjustment of pyrometers, thermometers, pressure gauges and similar instruments, as well as the liquid air apparatus. Every one was impressed by the very excellent work being done by this important government bureau.

In the evening the retiring president, Dr. F. W. Frerichs, presented three papers illustrating the solution of problems in chemical engineering practise as follows: "Manufacture of Chloroform from Alcohol," "Construction of Laboratory Apparatus," "Manufacture and Testing of Shipping Cylinders for Liquid Ammonia." The paper on the "Manufacture of Chloroform from Alcohol" was especially interesting, as it showed that by the use of denatured, duty-free alcohol, chloroform could be manufactured from alcohol under present conditions and sold at a profit. The paper on "Manufacture and Testing of Shipping Cylinders for Liquid Ammonia Gas" was supplemented by the paper on "Manufacture and Testing of Carbonic Acid Cylinders," by John C. Minor, Jr. By means of lantern slides the method of testing cylinders was shown, as well as the results of exploding such cylinders under fixed conditions.

On Thursday, the institute visited the United States naval proving grounds at Indian Head, Md. This proved one of the most interesting excursions of the meeting. Four shots were fired from a twelve-inch gun. The method of loading, testing the pressure developed in the gun and velocity of the bullet were shown and inspected with the greatest of interest.

The plants for contact sulphuric acid, nitric acid, the manufacture of ether, nitration of cellulose, powder presses, recovery drying, as well as the testing of the raw materials and finished product were inspected with the greatest of interest.

In the evening a subscription dinner was held at the New Willard Hotel. Addresses were made by Patent Commissioner Moore, Dr. Harvey W. Wiley and Admiral N. C. Twining.

On Friday morning the institute listened to a number of very able speakers on the United States patent system. A symposium had been arranged for the purpose of bringing out defects in the present system and recommendation of the remedies to be applied. The following papers had been prepared and were presented:

"The United States Patent Office," E. B. Moore, Patent Commissioner, U. S. Patent Office.

"Protection of Inventions by Patents. Existing Defects and Remedies Therefor," Walter D. Edmonds, of Edmonds & Peck.

"The United States Patent System," R. N. Kenyon, of Kenyon and Kenyon.

It was the consensus of opinion that the present methods for granting of patents in use at the

United States Patent Office are better than any in use by any government in the world. The deplorable condition at the Patent Office on account of congestion and overcrowding due to the failure of the congress to provide suitable quarters for this most important government office, was brought out not only in the papers, but in the visit to the Patent Office during the afternoon. This condition prevails in spite of the fact that the patent bureau has been operated with such economy that a surplus of seven million dollars has accrued during its operation from excess of income from patent fees over expenditures.

It was also brought out that the most serious defects in our present patent system are met by the inventor after his patent has been granted. Intolerable delays occur, and enormous expense is involved in patent litigation, so that in numerous cases the patentee who does not have the strongest financial backing is defrauded of his rights by wealthy and powerful corporations. The remedy suggested for this condition of affairs consists in the establishment of a patent court in which all patent cases will be held, and also the hearing of all testimony in such cases in open court instead of before a referee.

On Friday afternoon the educational discussion which has been carried on at various meetings of the institute was continued, and the committee on education was requested to formulate the opinion of the institute on this important question and transmit copies of same to the universities and technical schools in the United States giving chemical engineering education.

On Friday evening, a paper was read by Mr. F. G. Wheeler on the "Adaptation of the Centrifugal Pump to Chemical Service." A complete discussion of the theories of the pump and all designs and makes with their behavior under operating conditions was given. The pump was illustrated with numerous lantern slides giving views of the pumps discussed.

A number of members of the institute visited on Saturday the steel plant at Sparrows Point, Baltimore, and the cement plant of the Tidewater Portland Cement Co.

The attendance at the meeting was excellent, and general satisfaction expressed at the results accomplished.

J. C. OLSEN,
Secretary

POLYTECHNIC INSTITUTE,
BROOKLYN, N. Y.

SCIENCE

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FRIDAY, MARCH 29, 1912

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SCIENCE

FRIDAY, MARCH 29, 1912

THE CARNEGIE FOUNDATION FOR THE
ADVANCEMENT OF TEACHING¹

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IN March, 1911, Mr. Andrew Carnegie transferred to the trustees \$1,000,000 of five per cent. bonds of the United States Steel Corporation, the first instalment of the gift of \$5,000,000 offered in his letter of March 31, 1908.

This amount brings the funds at present in the hands of the trustees to a total of somewhat over twelve millions of dollars, of which eleven millions are invested in five per cent. bonds of the United States Steel Corporation and approximately one million, the result of accumulated surplus, is invested in other securities, purchased upon the approval of the finance committee and listed in the treasurer's report.

The total income at the disposal of the trustees for the fiscal year just ended amounted, as shown in the treasurer's report, to \$590,449.54.

The total expenditures of the trustees were distributed as follows:

Retiring allowances and pensions in accepted institutions—		
Teachers	\$341,899.16	
Widows	46,720.17	\$388,619.33
Retiring allowances and pensions to individuals—		
Teachers	\$122,215.10	
Widows	16,044.57	138,259.67
Salaries, publication, rent, etc.	53,564.21	
Total expenditure	\$580,443.21	

MESS, intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

¹ Extracts from the sixth annual report of the president, Dr. Henry S. Pritchett.

In the report of last year I sought to call the attention of the trustees and of teachers in colleges and universities to the specific things that a retiring allowance system could do, and also to the limitations of such a system. The experience of the past year prompts me to refer again to these limitations, and to the extreme difficulty of making exceptions to the rules framed for administering the income of the foundation.

The specific things that the system of retiring allowances maintained by the foundation offers to the college teacher are three in number: (1) a fair retiring allowance after sixty-five years of age; (2) a disability allowance after twenty-five years of service as a professor, in case of a failure in health so complete as to unfit him for his work as a teacher; (3) the payment to the widow of a professor who has had twenty-five years of service, of a pension equal to one half of the allowance he would have been entitled to at sixty-five. I am inclined to think that the protection of the wife and family thus provided is the most valuable and, in many cases, the most highly appreciated service that the system of retiring allowances can render. These benefits accrue to the teacher under specific rules, according to which he himself and the officers of his college may know, quite as well as the officers of the foundation, whether he has had a service which makes him or his widow eligible under these rules.

The executive committee of the foundation has spent much time over cases which, falling outside of these specific provisions, are urged upon their attention by college authorities, by friends of those desiring relief and by the applicants themselves.

These requests are justified in part by the action of the trustees in giving to the executive committee permission to extend the benefits of the retiring allowance to certain exceptional cases—notably to men who de-

sire to devote themselves to research, and to college executives who have rendered noteworthy service. As a matter of fact, the executive committee has never made use of this authority granted by the trustees, and I am convinced that the difficulties of making such exceptions are so great that the committee will find it necessary to abide wholly by the fixed rules.

The idea of giving, by the granting of a pension, opportunity to men of proved ability to devote their whole time to research was a very attractive one to the trustees and officers of the foundation at its inception. It was felt that a by-product of the retiring allowance system which would be of great value might here be obtained.

Unfortunately, experience has not justified this hope. This is due to a number of causes: partly to the fact that there are yet few men in the colleges and universities engaged in advanced research; partly to the tendencies of the colleges themselves and to the qualities inherent in human nature. Experience shows that under the encouragement offered by this action of the trustees, a considerable number of teachers who had done nothing in research hitherto suddenly discovered that they had a mission in that direction. Further, the college authorities were ready in many cases to recommend as qualified for research professors whom they had found ineffective as teachers. Finally, in the cases of men genuinely interested in research and prepared to undertake it effectively, there is some question whether such provision by the foundation would not weaken the sense of responsibility among the colleges toward research and those undertaking it.

The experience of the foundation in considering special cases among "those whose twenty-five years of service include noteworthy presidential or other administrative work in a college or university" has

brought out still more strongly the difficulty of making exceptions. Every college president considers his case an exception, and all of his friends consider the record of his services as noteworthy. A board of trustees dismissing a college president to make way for a new man will in most cases certify in the highest terms to the extraordinary character of the departing president. It is very true that most such men have given to their work a high order of devotion and of disinterested service; no college presidents are more deserving than some of those that are forced out by their boards of trustees. On the other hand, it is practically impossible to compare the records of such men and single out a few for recognition without doing great injustice to others. The hardships of college presidents—aside from those that arise from their own failings—come from the defects and the crudeness of our comparatively young educational system. Part of these are due to an over-production of colleges and consequently of college presidents. Compensation for such inequalities can not be brought about by the action of a pension agency. The cure must come from a gradual improvement in our educational organization, and a more enlightened attitude on the part of the public and of college trustees toward those who are responsible for educational administration. It is as difficult to select the especially deserving president or dean as to select the special teacher whose work has been of noteworthy character. The effect of such legislation by the trustees has been to arouse hopes on the part of many presidents that they might in case of such an emergency as dismissal from office be considered in a special class entitled to the receipt of a retiring allowance. The experience of the past five years shows that

the administration of such a rule is impracticable.²

Other requests and recommendations that come to the executive committee cover almost all possible variations from the rules. The most common are those in which the teacher has served for a shorter period than twenty-five years and suddenly breaks down in health or dies leaving a helpless family. These are indeed the most pathetic cases that one can meet. Here again, however, a little reflection will show how impossible it is to go outside of the established rules without embarking upon an entirely new pension system. Again, it is impossible for a pension system to take care of individuals who neglect to use reasonable prudence in the affairs of life. The teacher's salary is often pitifully small. To provide even modest insurance against the death of the breadwinner seems often too great a burden to add to the already heavy load. Oftentimes, too, the men who are thus cut down early are those who have thrown themselves into the service of education with a splendid enthusiasm, and sometimes with a reckless disregard of their own health and of the claims of their fam-

² At the meeting of the trustees, November 15, 1911, the action which empowered the executive committee to make exceptions in the cases of "those whose twenty-five years of service include noteworthy presidential or other administrative work in a college or university" was rescinded. No person has ever been retired under this authority. The only exceptions to the rules now recognized by the trustees are in the cases of men of proved ability in research, who would in the judgment of the trustees be able to render unusual service to science if free from teaching duties. Such cases will be extremely rare. Experience shows that research in general flourishes in the contact of investigator and student. No retirement has as yet been made under this provision. Such action would mean in any case the highest recognition the trustees could render of their appreciation of ability already demonstrated and of their expectation of still higher achievement to follow.

ilies. There should be somewhere some provision for such cases. But it is clear that the just remedy for such exceptional misfortune does not lie in a disregard, on the part of those administering the present pension system, of the rules established for the welfare of all. Some, at least, of these cases should be met by the colleges.

The presence of the altruistic spirit among college teachers is strong, but perhaps no stronger than among other classes of educated men. As in every calling, a large number of those in the profession of the teacher are drawn to it by bread and butter reasons. The offering of a pension can not fail in some cases to minister to the selfish side of human nature. There will always be some who, when they find themselves in possession of a given advantage, whether that take the form of a benefit in the hand or one to be acquired in the future, will trade upon the possession or the prospect of that benefit. Under the present rules there will be a certain number of teachers who will count the years and the days until the coming of the minimum age which enables them to resign the duties that they now perform in a perfunctory and machine-like way. There are still other men facing responsibilities and difficulties in administrative places or in teaching who would gladly use the method of the pension to escape from the perplexities and responsibilities of their positions. Presidents are prepared to prove to the foundation, even when they are turned out of office by the trustees for alleged incompetence, that they are entitled to a pension on the ground of extraordinarily meritorious service. Too many teachers, too, think that they are entitled to consideration of a special sort by reason of their particular and unusual service. All this arises out of the qualities of human nature, and out of

the qualities of some of the men who to-day make up the faculties of our colleges. On the whole, the number of those whose selfishness is directly touched by such an opportunity is small, as small perhaps as one ought to expect, and in the long run much of this spirit will disappear as the teachers themselves become accustomed to a system of pensions. In time teachers will realize that it is for their own interest and in the direction of their own happiness to continue to work as long as they are really fit and able to serve. The late William T. Harris always insisted that a college professor was at his best between the ages of sixty-five and seventy, and he strongly urged the trustees of the Carnegie Foundation at the inception of the trust not to make the minimum retiring age lower than seventy. Mr. Harris's argument was a partial one, but it had some truth in it. There are many teachers who are at their ripest and at their best between sixty-five and seventy-five, and such men ought, of course, to remain in their profession. In the long run it will be found that they will do so, although for a few years the idea of the pension will induce some men to surrender work at an earlier age than they ought. It is impossible to offer to men an advantage such as that which flows from a pension system of any sort without arousing in some minds the question, How can I get the most out of it? The number of such individuals among college teachers, however, is small, and will, unquestionably, become smaller as the standards of college life rise.

Nor can one shut one's eyes to the fact that the colleges themselves may, by reason of the pensions of the foundation, neglect their own duty in taking care of their old teachers. This also, in my judgment, is a temporary and passing phase of the situation. The officers of the foundation have

done all in their power to make it clear to the colleges that the funds at their command, and likely in the future to be at their command, could care for only a limited number of colleges. Nevertheless, in spite of this effort, it has been tacitly assumed by many colleges, and generally by those of the lowest standards in scholarship, that any obligation on their part to care for their old teachers vanished with the inauguration of the foundation.

Notwithstanding the disadvantages, however, that must occur in the administration of any such system of these pensions, it seems clear that the advantages that have resulted from the conferring of pensions have greatly outweighed the disadvantages, and that, furthermore, the advantages on the whole seem likely to become stronger with time, while the disadvantages tend to diminish. The value of a pension system depends not only on those who administer it, but no less on the spirit and *morale* of those who are to participate in its benefits. The dangers of a non-contributory system lie mainly in those universal dangers that come from human weakness and human selfishness.

It is, to my thinking, a fair question whether college pensions ought not, like other pensions, to carry a contributory feature. No one can be more sensible than I of the tremendous demands made upon the meager salaries of the American college teachers, and yet notwithstanding this, it is impossible to remove the college teacher from those social and moral influences that affect all men. The experience of the world seems to make clear the fact that on the whole a contributory form of pension is likely to be most just and least harmful.

The sacrifice of the individual to which I have referred is directly connected with the question, "What obligations rest upon a college to care for those who have grown

old or have broken down in its service?" This question is rendered more urgent by the establishment of the Carnegie Foundation. In every report of the foundation attention has been called to the fact that the income that it is likely to have can provide at most for only a small minority of the college teachers of the country. All that the trustees can hope to do is to establish the principle of a generous and fair retiring allowance system as a part of the régime of higher education in the United States. The question, What is the duty of the college in this matter? still remains, even to a considerable extent, in the accepted institutions. In these institutions the main burden of pensions is carried by the foundation, but the obligation of these institutions to care for those who have served them well, and who are not eligible to retirement under the foundation, still remains.

The question as to the duty of the college is, of course, only part of a larger question that all organizations in the social, educational and industrial circles of our country are now facing. The relation of a pension provision to efficiency and the obligation of a corporation to its servants is being discussed to-day from every point of view. The college must face this question just as other corporations are facing it. One does not need to be an extreme individualist to realize that the individual is too often sacrificed to the service of the corporation. Perhaps in no form of organization is this more often true than in the colleges. We need constantly to be reminded that colleges, as other human organizations, were made for men; men were not made for colleges. The obligation rests upon every organization in the social order to deal fairly with the question, how far it is accepting the sacrifice of the individual in order to promote the organization, or the

cause that the organization is supposed to serve.

This question presents itself in a very acute form in our colleges. A large proportion of the colleges overwork their teachers in the effort to take more students or to teach more subjects. College loyalty is constantly invoked to justify the placing of an additional burden on the shoulders of an already overworked teacher, and college loyalty looks less frequently to thoroughness and quality than size. Under these circumstances, is there not a clear duty resting upon the college authorities to use part of the income in their hands in the support of those who grow old or break down under this régime?

There is a widespread tradition that corporations have no souls. But of all soulless corporations, the colleges probably have the smallest compassion so far as the question of dealing with their old servants is concerned. Few business corporations would be as heartless toward an old officer as a very large proportion of American colleges are. In the most of these, a worn-out president, an aged professor or a teacher struck down by illness is simply turned out to shift as best he may. In fact, the college trustee has been surrounded by such influences that he invokes his responsibility as a trustee to justify the plea that under no circumstances can he use any of the income of the college, whether from endowment or tuition, to care for those who break down in the college service. It is exactly here that the question of the duty of the college arises. Has any corporation the right to use the service of individual men of high devotion and intelligence up to the end of their working ability, without assuming some responsibility for their future? Is it to the interest of society, of human progress, of education itself, that any corporation should divest itself of such

responsibility? This is a question that all organizations of society must face, and the college, to say the least, can no more escape it than can the industrial organizations. The colleges have undeniably failed in the ethical leadership that might have been expected in these matters. It is impossible, however, to believe that they will not rise to the moral standard now set by the business world.

The public perhaps scarcely realizes how indifferent the colleges have been in the past to this question. The correspondence of the foundation during the last five years throws an interesting light on this whole matter, and brings out in the sharpest relief the fact that the very idea that the college has a moral obligation to its worn-out professors has not yet presented itself to most college officers and trustees as one of the things with which they are to reckon.

Communications like the following are typical. The president of a board of trustees writes that Professor A., having served the college faithfully for twenty years and having broken down absolutely in health, is compelled to stop work altogether. He is without means and has a family. It is plain that he is not eligible, under the rules, to a pension from the Carnegie Foundation, but, writes the president of the board, will not the foundation waive its rules in this case in view of the high service and pathetic situation of the teacher and care for this excellent man? For, he adds, "Of course the college can do nothing." And yet this college had an income that is generous when compared with those of most colleges. It had spent a large sum on an athletic field the previous year, and it was spending at that time more money on advertising than would be necessary to pay such a pension several times over, and this in spite of the fact that it had more students than it could care for decently. The

college trustee needs to get a clearer perspective as to his obligations and those of his college.

An institution of large income and high standing applied to the Carnegie Foundation for the retirement of a dean, a man seventy years old, who had rendered to his institution a long and distinguished service, and who stood high in the affections of the old students. The retiring allowance was voted, in view of the long service and scholarly character of this man, and it only became known months later that the trustees had arranged, in case the pension were not granted, to dismiss this faithful servant on the ground of advanced age.

The reason for this lack on the part of college trustees of that sense of responsibility for the old servant which is so striking a feature of modern civilization does not lie in any extraordinary callousness on the part of college trustees. It arises simply out of the conditions of our American colleges as related to our educational problems. The college trustee has been so trained that he looks upon any such expenditure as wholly outside of those purposes for which the college can spend its money. Not infrequently a trustee puts his hand into his own pocket to relieve (at least temporarily) the situation of a broken-down teacher, when his conscience would not allow him to spend a cent of the college money for such a purpose. Exactly the same thing happens in churches. An old and worn-out pastor is turned out to spend the remnant of his days in abject poverty—helped out now and then by casual gifts or meagre pensions, while the officers of the congregation would feel hurt at any suggestion that they had acted ungenerously. Yet it seldom occurs to them that the affectionate support of an old and faithful servant through his declining years would probably be the most christian act that the

congregation could perform. This whole matter has not yet been brought within the perspective of college trustees. The time has come when this must be done. It is probably true that only a few colleges are in a position to maintain a satisfactory and generous pension system for all their teachers, but no college that is prepared to educate youth with fair efficiency is exempt from the obligation to make modest provision for those who have served it long and faithfully and who have come to the limit of their working capacity. This is simply one of the ordinary obligations of human society which all corporations in a civilized christian community must acknowledge. It is worth more to the education of young men to provide a decent support for an old teacher than to build athletic fields or even to add a new dormitory. On the other hand, a broken but deserving teacher, turned out to shift for his remaining years as best he may, is a spectacle which does more harm to the cause of education than can be atoned for by large classes of undergraduates, or a graduate school conducted at the expense of the legitimate work of the college. In a word, the obligation to care for the old servant is one of the fundamental obligations of human society, and the college can not evade it without incurring the sort of penalty which follows the evasion of all obligations. According to its ability, every college, however modest, must meet this obligation. The board of trustees that turns out an aged and faithful teacher with the phrase, "Of course the college can do nothing," simply does not appreciate that such an act is a blow at the integrity of the educational cause that they are supposed to serve, and that it is better for the college itself to make its economies elsewhere than in the evasion of the old-fashioned christian obligation to care for those who have borne the burden and heat

of the long day. The appreciation of this fact on the part of the great number of college trustees has hardly begun. It will be a matter of slow education, but it will come, and in just such proportion as standards of honesty, of sincerity and of human brotherhood improve in the colleges themselves.

And it is fairly safe to say, from past experience, that progress in these moral standards will follow close upon progress in scholarly standards. Educational righteousness will not be divorced from other forms of right living. The college which holds up sincere and fair scholarly standards will in the long run be the college that will bring to its service trustees who can face intelligently all their obligations, whether they be to the college as a whole or to the individual student or teacher.

In the present status of higher education in America there are many conditions that make it easy for college trustees to disregard the obligation to the individual in the face of numerous demands in other directions. In almost every state of the union there are more colleges in name than the country needs or can afford. They have been started without much regard to the ultimate educational demands. Many of them have existed by doing the work of high schools, and now that the high school system of most states is being rapidly developed, many of these institutions, founded in an educational enthusiasm and having neither the means nor the facilities for doing college work, have a hard struggle for existence. Denominational, state and local rivalries have done much to swell this list of weak and often superfluous colleges. In many cases their existence makes impossible that of good high schools which would far better serve the educational interests of the community.

For example, in Nebraska, which had a

population in 1910 of 1,192,214, there are thirteen colleges and universities, all in the fertile and populous southeastern quarter. One of these thirteen institutions is the well-supported and accessibly located state university, another is a university conducted by the Jesuit Fathers, and a third is a privately endowed institution. Each of the remaining ten colleges was founded by a protestant denomination, is controlled by it, and appeals to the denominational constituency for support. One of these colleges gives in its catalogue no means of estimating the number of its college students. The other nine have a total college enrollment of 841, or an average of 93 college students each. The total enrollment of all of the departments of these institutions, apart from summer schools, is 3,051, or an average of 340 each. It thus appears that these colleges, founded in days of pioneer enthusiasm or of boom prospects, and maintained by efforts of denominations and the sacrifices of individuals, are chiefly engaged in preparatory, music and business school work, rather than in college education. To reduce these ten struggling colleges to two or three would relieve many conscientious people from severe financial pressure, and would greatly improve the level of higher education in Nebraska.

Similarly, in Pennsylvania, there were, at last reports, fifty-one institutions calling themselves universities or colleges. A baker's dozen of these are wholly secondary schools, in no way entitled to the name of college. Three universities in Pennsylvania can perhaps make that title good. There is one state college. There are also six worthy non-sectarian colleges. The remaining twenty-eight institutions are denominational schools and colleges—six of the Roman Catholic church, five of the Lutheran and five of the Presbyterian denominations. Three other denominations

have two colleges each and six others have one each. At least half of these denominational institutions are small, struggling and of low educational standards. One of the Presbyterian "colleges," for instance, is made up of 164 preparatory and 44 college students. One of the Lutheran "universities" is composed of 35 preparatory, 48 collegiate, 12 professional and 17 *graduate* students, 15 of the latter being non-resident. Assuming that the denominations can make real contributions to higher education, such multiplication as this is surely unjustifiable. Its effect is to reduce all education to a lower level and to depress all betterment of the teacher's place.

When an institution calling itself a college hires its professors by the month, and pays such salaries as only youths just out of college can accept, it is not to be expected that a high sense of obligation will characterize its trustees. In the gradual process of the country's growth such institutions will either disappear or find their true place, many of them as secondary schools. But, meanwhile, it is not in these institutions that one must expect a just sense of appreciation of a professor's service. It is in the stronger colleges, whether small or large, that one must expect the beginning of the movement for a just recognition of the obligation that the college owes to an old and faithful servant.

Quite naturally, the creation of the Carnegie Foundation conveyed to many college boards the impression that the establishment of such an agency lifted at once from the shoulders of college authorities all obligation to care for their worn-out or disabled teachers. The very opposite is the fact. The creation of the Carnegie Foundation makes clear and emphasizes the obligation of educational organizations to deal justly, thoughtfully and generously with those who have given a life's service

to education. The very purpose of the fund is to arouse in college authorities an appreciation of this obligation. The trustees of the foundation can provide retiring allowances for only a small fraction of the college teachers of America. The duty of the individual college in this matter still remains, and is but the greater now that the principle has been made clear.

GENERAL EXAMINATIONS IN A MEDICAL
SCHOOL: PLAN OF EXAMINATION
RECENTLY ADOPTED AT
HARVARD¹

THE curriculum of the medical school has been a frequent topic of discussion in recent years. This association has devoted much attention to it and it continues in one form or another to occupy much of our time. A minimum curriculum requirement for a standard medical school is the basis for admission of a medical college to the Association of American Medical Colleges, and we determine the ability of the school to give efficient instruction within the limitations of this curriculum before we accept them for membership. It is clearly understood that we have fixed a minimal standard, but make no attempt to mould each school after a single fixed model. It is recognized that variations in personnel, in physical equipment and in local conditions make impossible the same type of teaching in every school. Were this possible, it would not be desirable, for no surer means of stopping progress could be conceived. It is the duty of each of us to try new methods and to share with others the experience so gained. From this alone can improvement come.

It has seemed to us at Harvard that medical schools have tended toward too great a rigidity of curriculum with too many separate examinations. This has resulted in leaving too little to the initiative of the student and in producing students too crammed with facts, too little able to think and to apply intelli-

¹ Read at the meeting of the Association of American Medical Colleges held in Chicago, February 28, 1912.

gently their knowledge. For some years we have been attempting to change this condition, and various steps toward this end have been taken. The plan of fourth-year electives on which I reported to you at a previous meeting in connection with the concentration system of teaching² was a step in this direction. This year we took another step in adopting a new plan of examination, which we believe will serve a twofold purpose, lessening the rigidity of the curriculum, and facilitating the correlation between the different subjects of the curriculum by placing before the student a new form of test for which he must seek to prepare himself.

The new plan of examination goes into effect with the class entering next year, and will not be applied to the classes in advance of that. Consequently four years will elapse before it has been tested in its entirety on one class. To at least five classes it should be applied before any opinion as to its real value can be given. At this time I can only explain the plan as we propose to try it. It may be of interest for you to know of it; perhaps some will care to apply it in their school. We believe it to be a distinct improvement and one that will lead to other changes in the curriculum. Already with this in view a committee has been appointed to restudy the curriculum and to propose any changes needed to meet these new conditions. The new plan of examination is to be regarded as part of a larger plan being worked out gradually and intended to improve our medical instruction.

The new plan of examinations is as follows. Written tests at the end of each course were formerly held. These are done away with, and in their place practical examinations are to be held, which are the only examinations conducted by the individual departments. The general committee in charge of examinations has supervision over the practical examinations, and they are to be a measure of the student's practical knowledge and skill. The student may choose whether he will take the practical examinations at the end of each

course, or near the time of the general examination. Practical examinations in all courses included in a general examination must be satisfactorily completed before the student will be admitted to the general examination. The practical examinations are to be graded and the marks so received are to make up 40 per cent. of the grade given on a general examination.

There will be two general examinations, one at the end of the second, the other at the end of the fourth year. Both will be partly written, partly oral. The subjects comprised in the first will be anatomy, histology and embryology, physiology, biological chemistry, pathology and bacteriology. Furthermore, this examination shall assume and require an elementary knowledge of physics, inorganic and organic chemistry and biology. The subjects comprised in the second general examination will be preventive medicine and hygiene, materia medica and therapeutics, medicine, surgery, pediatrics, obstetrics, gynecology, dermatology, syphilis, neurology, psychiatry, ophthalmology, otology and laryngology. For the first general examination the student may choose either June or September, for the second, either June or January. This difference in time is due to the custom at Harvard of awarding degrees both at mid-year and at Commencement. No student who fails to pass a general examination may repeat it within the calendar year in which he failed. No student will be permitted to begin the work of the third year until the first general examination has been passed. Consequently there will be no men carrying on work conditioned in previous courses.

The written part of each general examination will consist of questions selected and arranged by the committee on examinations from lists of questions submitted by the departments concerned. The written test will be divided into two or more periods of three hours each, but there will not be separate examinations on the various courses. The answers to the questions will be graded under the direction of the committee on examinations, not under the direction of a depart-

² *Bulletin of American Academy of Medicine*, Vol. XI, No. 6, December, 1910.

ment. Thus in large measure the student is examined not by the man who gave the course. A single question may involve knowledge acquired in the work of several departments, and all questions are to be answered from this broader viewpoint and not from the viewpoint of any particular course. The grade so given on the written part of a general examination will make up 40 per cent. of the final mark for the general examination.

The oral part of each general examination will be conducted by boards of five members appointed by the committee on examinations, on each of which for the first general examination there must be at least one representative of the clinical branches, and for the second general examination at least one representative of the laboratory subjects. The board will determine by conference and vote the grade of the student, and the grade given on the oral part of a general examination will make up 20 per cent. of the final mark of the general examination.

This, then, is the plan for examination which we have voted to adopt. It is, as you see, a very considerable departure from the type of examination generally in vogue in medical schools. Practical examinations are given at present in most of the medical courses at Harvard. These will continue to be given. The present large number of written examinations will be reduced to two, to which are added two oral examinations, both planned to determine the student's comprehension, judgment and power rather than his detailed information. I will not occupy your time with any more minute description of the plan, and I will not enlarge upon what I consider to be its very great merits. We believe it to be a great improvement on our present system, but I will not engage in prophecy as to what it will accomplish; some years hence it can be reported again, and the reporter then will give you a criticism of its practical application with a statement of what modifications actual practise has required in it.

HENRY A. CHRISTIAN

BOSTON

DR. A. R. WALLACE AND THE UNIVERSITY
OF COLORADO

In the general biology class at the University of Colorado it is customary to give a good deal of attention to the theory of evolution, and to the history of biological science. The class (about 135 students) of this year became much interested in the character and work of Dr. Alfred Russel Wallace, and took the liberty of sending him the following greeting on the occasion of his eighty-ninth birthday:

We, the students in the general biology class at the University of Colorado, ardent admirers of your work on evolution, send you respectful greetings on the occasion of your eighty-ninth birthday, wishing you health and happiness.

To this, Dr. Wallace replied in a letter dated January 12, 1912:

My dear Young Friends:

Thank you much for your very kind greetings. I am much pleased that so many of you are readers of my books. The wonders of nature have been the delight and solace of my life. From the day when I first saw a bee-orchis (*Ophrys apifera*) in ignorant astonishment, to my first view of the grand forests of the Amazon; thence to the Malay Archipelago, where every fresh island with its marvellous novelties and beauties was an additional delight—nature has afforded me an ever-increasing rapture, and the attempt to solve some of her myriad problems an ever-growing sense of mystery and awe. And now, in my wild garden and greenhouse, the endless diversities of plant life renew my enjoyments; and the ever-changing pageants of the seasons impress me more than ever in my earlier days.

I sincerely wish you all some of the delight in the mere contemplation of nature's mysteries and beauties which I have enjoyed, and still enjoy.

Yours very truly,

ALFRED R. WALLACE

HENRY WILSON SPANGLER¹

In recording the death, on March 17th, of their friend and associate, Henry Wilson Spangler, Whitney Professor of Dynamical Engineering, the members of the University Faculties feel moved to give expression, how-

¹ Minute adopted by the faculties of the University of Pennsylvania.

ever inadequately, to the great loss that has come to the university in the departure of one of her most efficient and devoted servants, and to their profound sense of personal bereavement in the death of a staunch friend and wise counsellor.

With the exception of a three-year period of service in the United States Navy, Professor Spangler has been a member of the faculty of the university since 1881. For more than a quarter of a century he has labored for the advancement of the important interests committed to his trust, with a singleness of purpose and a self-sacrificing devotion that served as an inspiration to his associates, from the humblest to the highest. Endowed with quick initiative, resourcefulness, courage and self-reliance, his qualities of leadership stood out at their best at times of emergencies, such as the destruction by fire of the old Mechanical Engineering Building, and the almost immediate and orderly resumption of activities in an incomplete, new building, with such facilities as could be quickly improvised. A strict and almost military disciplinarian, he was no less rigid in the standards which he applied to himself. The respect and admiration in which he was held by his students ripened into affection as they came to see him at closer range, and recognized the bigness of heart and the warmth of friendship that lay, poorly concealed, by a certain mantle of austerity. There were few graduates who failed to turn to him at some time for helpful counsel in the perplexities of later years, or who had failed to accept it, even though it ran counter to their own promptings. They had implicit confidence in his judgment, and knew that his advice sprang from genuine, almost paternal solicitude for their welfare, and that it was never given lightly. For some years before his death, he published, at his own expense, and sent monthly to every graduate of his department, a little pamphlet called the *Connecting Rod*, designed to give them information about the department and about each other, in a simple, unaffected way. Everything he did, for that matter, was done in a like manner, for none

had a more wholesome contempt for the vanities, affectations or shallow pretenses of man.

He possessed to a remarkable degree the faculty of perceiving clearly, and almost intuitively, the essential elements of a seemingly difficult problem or complex situation, and he was as quick in action as in perception. Few excelled him in the clear discernment of the fallacies of an argument or in the directness of the challenge of such fallacies. Of a thoroughly progressive bent, he did not allow himself to be carried away by the educational fads and follies of the hour. The business of education was, to him, a serious business, with which liberties were not to be lightly taken. Although his talents were frequently brought into requisition in outer circles, his duties as a teacher were, to him, ever of paramount importance, on which he allowed no professional obligations of a busy lifetime to trench unduly.

His university friends find it hard, indeed, to realize that his commanding figure has been seen upon the campus for the last time, and that in their councils his voice is stilled forever. None know better than they the sterling worth, the far-reaching significance of his performances in the service of the university, and especially of the department for which he had planned and labored so indefatigably, with such wholehearted devotion, and on which he has left the enduring impress of his rare powers.

THOMAS HARRISON MONTGOMERY¹

THE University of Pennsylvania has suffered an irreparable loss in the death of Dr. Thomas Harrison Montgomery, Jr., Professor of Zoology, who has done so much to illumine his favorite science, and who has endeared himself to his colleagues, both in this and other universities, at home and abroad.

Professor Montgomery was a son of the late Thomas Harrison Montgomery, for many years president of the American Fire Insurance Company of Philadelphia, who was a descendant of the Montgomeries of Eglinton, an

¹ Minute adopted by the faculties of the University of Pennsylvania.

ancient Norman family long settled in Scotland. He was also a great, great grandson of William White, D.D., LL.D., a graduate and trustee of the University of Pennsylvania, and first Bishop of the Protestant Episcopal Diocese of Pennsylvania. Professor Montgomery's mother, Anna Morton, was the daughter of Samuel George Morton, one of the founders of the science of craniology, and president of the Academy of Natural Sciences of Philadelphia, which is but this week celebrating its centenary.

Professor Montgomery was born in New York, March 5, 1873, and early manifested traits worthy of his ancestors. After two years as a student in the University of Pennsylvania, 1889 to 1891, he resolved to continue his studies in the University of Berlin, and secured his family's consent to the plan. His indefatigable industry immediately attracted the attention of his fellow-students, one of whom has related his astonishment at seeing a boy of eighteen working with unflagging zeal eighteen hours a day, with almost no rest or recreation, in the simultaneous acquisition of a difficult language and a group of the natural sciences. He received his degree of Ph.D. from the University of Berlin in 1894, and shortly after his return to America, was assigned by the University of Pennsylvania, a room for research work in the Wistar Institute, being the first person so appointed. During the next four years he labored with the same never failing energy, issuing a series of brilliant monographs upon some of the most difficult problems of zoology. In 1898 he was appointed assistant professor of zoology in the University of Pennsylvania. In 1903 he was called to the University of Texas as professor of zoology, but in 1908 he was recalled to take charge of the department of zoology in the University of Pennsylvania. Shortly afterward he was intrusted by the university with the chief responsibility for the planning and construction of the new Zoological Laboratory. Into this labor he threw himself with his usual untiring energy, giving personal attention to every detail. This building was completed and dedicated in 1911, and will

stand as a monument to his foresight and his executive ability.

The results of Professor Montgomery's research in the technically difficult problems of cellular structure and its relation to the phenomena of heredity and the determination of sex; in the activities, habits and development of spiders and birds; in the structure and development of various rotifers and insects and in the analysis of racial descent and of evolution, have been embodied in more than eighty published monographs. He has also published a volume, "Analysis of Racial Descent in Animals," 1906, and has left in manuscript a nearly completed work on cytology.

Professor Montgomery married, in 1901, Priscilla Braislin, daughter of John and Elizabeth Braislin, of Crosswicks, New Jersey. He is survived by his widow and three sons. Professor Montgomery was essentially a scholar and teacher, and for the greater part of his short life, his energies and interests were largely absorbed in his professional work, but he was much more; he was a man of the most sterling integrity, carrying into all the relations of life the sincerity, candor and faithfulness to truth which made him great in the realm of science. Those of his colleagues on the faculty, who came only professionally into contact with him, will, perhaps, remember these traits most vividly; but those of his friends who were privileged to know something of his home life, of his wholesouled devotion as husband, father and friend, will carry with them memories not less vivid and even more true of a noble and lovable man whose loss they will not cease to mourn.

We, his fellow-professors in the University of Pennsylvania, extend, therefore, to Mrs. Montgomery and the other members of his family, our sincere sympathy in their bereavement, and direct the secretary to transmit these resolutions to the public press and the scientific journals in testimony of Professor Montgomery's distinguished services to science, education and the University of Pennsylvania, and as an expression of the esteem

and regard in which he is held by all his friends and associates.

SCIENTIFIC NOTES AND NEWS

PROFESSOR RALPH STOCKMAN TARR, head of the department of physical geography at Cornell University, known for his important contributions to geology and geography, died on March 21, aged forty-eight years.

THE resignation of Charles Loring Jackson, Erving professor of chemistry at Harvard University, has been accepted to take effect on September 1. Professor Jackson has been on the teaching staff of the university for forty-four years.

DR. HENRY S. CARHART, late professor of physics in the University of Michigan, now retired on a Carnegie grant, has become connected with Throop Polytechnic Institute, in Pasadena, where he has taken up his home. He will have a special laboratory equipped with apparatus for his researches in the institute.

PROFESSOR JOHN F. HAYFORD, dean of the college of engineering of Northwestern University, has been appointed a research associate by the Carnegie Institution of Washington and has received a grant of \$6,000 in aid of his investigation of the laws of evaporation and steam flow.

M. BIGOURDAN, of the National Observatory, Paris, has been elected president of the Paris Bureau des Longitudes for the present year. M. Baillaud becomes vice-president and M. Andoyer, secretary.

THE Entomological Society of America has named Professor J. H. Comstock, Cornell University; Dr. Henry Skinner, Academy of Natural Sciences, Philadelphia; Dr. P. P. Calvert, University of Pennsylvania; Professor Herbert Osborn, Ohio State University; Professor Vernon L. Kellogg, Leland Stanford Jr. University, and Dr. W. J. Holland, director of the Carnegie Museum of Pittsburgh, as delegates to represent the society at the Second International Congress of Entomology, to be held at Oxford, England, from August 5 to 10, 1912.

PROFESSOR WILLIAM H. HOBBS, professor of geology, has been appointed by President Hutchins to represent the University of Michigan at the two hundred and fiftieth anniversary of the Royal Society of London, which will be held from July 16 to 18. Professor Hobbs has leave of absence for the coming year.

* M. LIPPMANN, president of the Paris Academy of Sciences, will represent the academy at the celebration of the two hundred and fiftieth anniversary of the granting of the second charter to the Royal Society, which will be celebrated in July.

VICE-PRESIDENT T. J. BURRILL and Professor S. A. Forbes, of the University of Illinois, have been in the east attending the anniversary celebration of the Philadelphia Academy of Natural Science.

DR. ADOLF MEYER, professor of psychiatry in the Johns Hopkins Medical School, sailed on March 16 for Switzerland.

FREDERICK H. BLODGETT, Ph.D. (Hopkins '10), acting professor of biology and geology, has resigned from Roanoke College and assumed the duties of plant pathologist and physiologist at the Texas Experiment Station, College Station, Texas, on February 1. The work interrupted by the sudden death of Dr. Raymond H. Pond last summer will be resumed and some additional attention paid to plant diseases.

PROFESSOR ELLSWORTH HUNTINGTON, of Yale University, delivered three illustrated lectures on the "Desert," at the University of Michigan, beginning on Wednesday afternoon, February 28. In his first lecture he discussed Chinese Turkestan; Thursday, Palestine, and on Friday, March 1, "Historic Changes of the Climate in Relation to Geographical Effects."

ON March 1, Dr. C. F. Hodge, professor of biology in Clark College, lectured before a convocation of the students and faculty of Indiana University, on "Civic Biology." In the evening Professor Hodge addressed the members of Sigma Xi and invited guests on the teaching of biology.

THE Philadelphia section of the American Chemical Society held a meeting at the John Harrison Laboratory of Chemistry, the University of Pennsylvania, on March 22, when Dr. L. H. Baekeland, research chemist of New York City, delivered an illustrated address on "The Theory and Technicology of Baekelite."

THE Chemical Club of the University of Illinois is giving a series of lectures on "The Field of Chemistry," endeavoring to help the younger student in chemistry to "find himself" and to show him the economic or "dollar and cents" situation. Professor A. V. Bleining, Professor Edward Bartow, S. W. Parr and H. S. Grindley will speak on the divisions in which they are interested.

THE twelfth lecture of the Harvey Society series was delivered by Dr. W. S. Thayer, of the Johns Hopkins University, on March 23, at the New York Academy of Medicine, the subject being "Malaria."

A COMMITTEE has been formed to erect a monument in honor of the late Dr. Janssen, the eminent French astrophysicist.

A BUST of Henri de Lacaze-Duthiers, the distinguished founder of the Zoological Station at Roscoff in Brittany, is to be erected upon one of the public squares at Roscoff, near the laboratory and fronting the sea. The execution of the bust, which is to be mounted on a shaft of granite, is to be entrusted to a Breton artist, M. Guilloic. Professor Yves Delage, 16 Rue du Docteur Berger, à Sceaux (Seine), acts as secretary of the committee in charge of the proposed monument.

EDWIN SABINE RENWICK, a well-known consulting engineer, son of James Renwick, professor of chemistry and natural philosophy at Columbia University, has died at the age of eighty-nine years.

THE International Association of Medical Museums will meet at the University of Pennsylvania, Philadelphia, on April 4, and the American Association of Pathologists and Bacteriologists at the same place on April 5 and 6.

THE Washington Academy of Sciences held a conversazione, with an exhibit of new and

interesting apparatus from the U. S. government and other scientific laboratories of Washington, in one of the rooms of the new National Museum on March 28.

PROFESSOR GEORGE D. HUBBARD, head of the department of geology in Oberlin College, has concluded plans for a field expedition for advanced students in connection with the work of the Oberlin Summer School. The party will leave at the close of the college year for West Virginia where New River cuts through the Appalachian Mountains, entering a territory containing examples of an unusually large number of geologic phenomena. Students furnish their own tents and equipment and camp during the entire trip, remaining in the field seven weeks and two days. This year for the first time women students will be admitted to the course. Mrs. Hubbard will accompany the expedition. Dr. Lynds Jones, associate professor of animal ecology, will conduct a field ornithological expedition to Point Pelee on Lake Erie, where special investigations will be made regarding bird migration.

THE twenty-third annual session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences will be held at Cold Spring Harbor, Long Island, New York, during the summer of 1912. Regular class work begins June 26 and continues for six weeks. Courses are offered in field zoology by Drs. Walter, Davenport and Kornhauser; in bird study by Mrs. Walter and others; in comparative anatomy in charge of Professor H. S. Pratt, Haverford College; cryptogamic botany in charge of Professor H. H. York, of Brown University; training course for field workers in eugenics in charge of Mr. H. H. Laughlin, of the Eugenics Record Office with lectures by Dr. C. B. Davenport. Facilities are offered for investigators. Further details are given in the announcement of the laboratory which may be obtained by addressing the director, Cold Spring Harbor, Long Island, N. Y.

ACCORDING to astronomical bulletins sent by Professor Edward C. Pickering, director of the Harvard College Observatory, the history

of the new star, Nova Geminorum, No. 2, is given below. Results obtained at Harvard are indicated by the letter (H). Sunday, March 10, Nova not visible on a plate showing stars of magnitude 11.5 (H). Monday, March 11, Nova well seen, magn. 5 (H). Tuesday, March 12, Nova discovered by Enebo, at Domaas, Norway. Magn. 4. Wednesday, March 13, cablegram received at Harvard and distributed throughout America. In evening, Yerkes and (H) find spectrum of class F5, unlike other novæ. Hydrogen lines strong and dark. University of Michigan finds hydrogen lines bright and recession 5 km. from dark lines. Magn. 3.8 (H). Thursday, March 14, Yerkes and (H) find marked change in spectrum, hydrogen lines bright on edge of great wave length, like other novæ. Magn. 3.5 (H). Friday, March 15, photograph through thick clouds show nova faint magn. 5. Hydrogen lines very bright (H). Saturday, March 16, magn. 6, spectrum like normal nova spectrum. Nebule lines first seen. A star magnitude 14 in place of Nova on several early plates. A letter received at this observatory from Professor Frost states that a photograph of Enebo's Nova, taken on the evening of March 15, shows that "The bright lines of hydrogen are very broad and there are many other bright bands and dark lines throughout the spectrum. The bright H and K, at about their normal positions, are strong and broad and are crossed by very sharp, dark lines. The helium lines $\lambda 4923$ and $\lambda 5016$ are strong, both bright and dark. Helium $\lambda 4472$ is not conspicuous, but probably present." The following telegram, dated March 19, has been received from Dr. W. F. King, of the Ottawa Observatory: "Spectrum Nova Geminorum by Plaskett March eighteen seven tenths, numerous bright bands, maxima to red, and several narrow absorption lines, calcium, magnesium, iron. Velocity of recession about seventeen kilometers, magnitude about five and a half."

AMONG the changes recommended at the University of Chicago in the recent report of President Judson, is a readjustment of the time element in precollegiate courses by the School of

Education, a tentative scheme being as follows: "From the age of six to twelve, the elementary school; twelve to fifteen, the secondary school; fifteen to eighteen, the college (a junior college); the years following eighteen, the university. From the university at the age of twenty the student might take the baccalaureate degree, at twenty-one the master's degree, at twenty-two or three the various doctors' degrees. At the age of twenty-five or six if he enters on professional life he should be engaged in its practise, and by the time he is thirty he should be well established. In like manner at the age of twenty, if a student desires to enter on business he should be ready to do so, or if on the whole he prefers to enter business immediately from the three years of the college instead of entering the university at all he could do that with good training at the age of eighteen."

THE two federal bureaus engaged in the search for potash—the Bureau of Soils of the Department of Agriculture and the Geological Survey of the Department of the Interior—are in receipt of promising telegraphic news from their field representatives. A potash deposit of apparently great importance has been discovered at Borax or Searles Lake in the northwestern corner of San Bernardino County, California. This lake or playa is the last remaining pocket of a once much greater lake which has almost dried up and its central depression contains a large body of crystalline salts known to consist of common salt and sulphate and carbonate of soda with smaller quantities of borax. This salt body is saturated with brine, and interested persons stimulated by the governmental search for potash recently secured an analysis of old sample material from this brine. The result being significant, the lake was visited jointly by representatives of the Geological Survey and of the Bureau of Soils who took brine samples from six wells distributed over the salt flat. Analyses of these samples have been made by the cooperative laboratory at the Mackay School of Mines, at Reno, Nevada, and show an average of 6.78 per cent. of potassium

oxide (K_2O) in solution. The average salinity of the brine is 43.82 grams of solids per one hundred cubic centimeters. Comparison of the results indicates that the brines are nearly uniform throughout the flat. The probable importance of the deposits is due to the occurrence of the potassium salts in soluble form in a natural saturated brine, and under climatic and other conditions especially favorable to its separation and recovery by solar evaporation. Existing data give reasonable assurance that the brine-saturated salt body is at least 60 feet thick and covers an area of at least eleven square miles. Assuming the salt body to contain twenty-five per cent. by volume of the brine, the total amount of potassium oxide is estimated at over four million short tons. This estimate is believed to be very conservative, and the available tonnage may well be expected to exceed ten million tons, which would supply the country, at the present rate of consumption of potash, for thirty years. At any rate it appears that this locality constitutes a very important source of potash in probably readily available commercial form.

As a result of the recommendations recently made by a joint committee of the South African Association for the Advancement of Science and the Royal Society of South Africa, a general committee, says *Nature* quoting from *The South African Journal of Science*, has been constituted for the purpose of considering applications received for grants. Five grants, amounting in all to £250, were made at the first meeting of the committee held towards the end of last year. The grants were: (1) £40 to Professor W. A. D. Rudge, of Grey University College, Bloemfontein, to obtain a continuous record of the variations in the atmospheric gradient at various places, and to ascertain the relation between potential gradient and altitude, and between the diurnal variation of the gradient and the variation in the atmospheric pressure; (2) £45 to Professor A. Young, of the South African College, Cape Town, to investigate the occurrence of semi-diurnal, diurnal and spring and neap

tides observed in connection with an artesian well in the Cradock district; (3) £75 to Miss D. F. Bleek, to proceed to the Kalahari, so as to obtain phonographic records of the spoken language of the Bushman tribes north of the Orange and Vaal rivers; (4) £50 to Mr. R. N. Hall, to visit localities in Rhodesia, where Bushman paintings exist; (5) £40 to Mr. W. T. Saxton, of the South African College, Cape Town, for the purpose of studying the fungus diseases of trees in the Transkeian forests, investigating the ecology of the typical formations of the Transkeian territory, investigating a reported occurrence of the typical western province flora at St. John's, and to collect material for the study of the two genera of South African cycads, *Stangeria* and *Encephalartos*.

Dr. G. D. THOMSON, of Canton, writes the *Geographical Journal* an account of some caves in the south of the Kwang-tung province, which, he says, have never yet been described by a European traveler. They lie about 250 miles southwest of Canton, by the route followed by boat. This involves the descent of the Canton River to the sea, and a coasting voyage west to the mouth of the Yeung-Kong River, which is ascended to the city of the same name. Here it is necessary to change boats, taking a native craft, pulled or poled by native men and women when the wind is contrary. In this way the walled city of Yeung-chou is reached, and the caves are situated a mile or more to the west of it. The chief cave is of large size and very beautiful. The hills in the immediate neighborhood rise abruptly from the plain in jagged rocky cliffs of totally different formation from the surrounding hills and mountains. At the entrance and on ledges high up the cliff there is a Buddhist monastery and shrines, presenting a gaudy appearance. From the outer chamber, which is beautified with stalactites and stalagmites, a flight of steps leads up to a second, cathedral-like cavern, not visible from the first. In this there is a stone table and stools, and shrines around the walls in niches, but the whole upper part is untouched by

man. At the far end a passage lets in the daylight from the opposite side of the hill. Dr. Thomson proposes to call this group of limestone caves by the name of Lord Kinnaid, in gratitude for the kindness shown to him and his brother during their college days. He refers also to various other groups of caves in the same province, which make of this part of China a veritable cave country. Though they have been described by Dr. Henry in his book called "Ling Nam," they are far from being generally known. They include the "Cathedral cave" (so named by Dr. Noyes, of Canton) and others to the north of that city on the Lien-chow and North rivers; and those in the neighborhood of Shiu-hing on the north bank of the main Si-kiang or West River.

In connection with the graduate course in Highway Engineering at Columbia University, the following illustrated lectures have been given during the month of March by non-resident lecturers in highway engineering at 8:30 P.M.

March 4—"Slack-clay Roads and Oil-cement-concrete Pavements," Logan W. Page, director, United States Office of Public Roads, Washington.

March 8—"Mixing Plants for Bituminous Pavements," Francis P. Smith, chemical and consulting paving engineer, New York City.

March 11—"Comparison of Pavements," George W. Tillson, consulting engineer to the president of the Borough of Brooklyn, New York City.

March 15—"The Construction and Maintenance of Park Roads," John R. Rablin, Massachusetts Metropolitan Park Commission, Boston.

March 25—"The Organization of the State Highway Department of New York," John A. Bensel, New York State Engineer, Albany.

March 27—"Asphaltic Crude Oils and their Use in Highway Construction," Dr. Albert Sommer, Consulting Chemist, Philadelphia; or

"The Construction and Maintenance of European Roads," Arthur H. Blanchard, professor of highway engineering, Columbia University.

SEVENTY departments of the University of Wisconsin will be represented in the first exposition held at a university, which will

take place at that institution on April 19 and 20. Dr. Hermon C. Bumpus, business manager of the university, formerly director of the American Museum of Natural History, and Professors Stephen W. Gilman, of the course in commerce, C. K. Leith, of the geology department, and K. L. Hatch, of the college of agriculture, will comprise the faculty committee that will cooperate with 300 senior students in preparing for this exhibition. The engineering school will be represented by over 50 mechanical devices shown by its various departments. Among the interesting exhibits of the college of agriculture will be a model dairy and a model barn. Regular milking time will be announced so that visitors to the exposition can see mechanical milking machines in operation. The university bacteriological department will have an exhibit showing how many germs are afloat in the air of Madison, Milwaukee and Chicago. Plates will be put on the street corners in these cities for ten minutes and then will be put on exhibition to show the vast number of germs present in city air. Germs of hydrophobia and tuberculosis will also be on exhibition to be viewed through the microscope. How disease is transferred by handshaking will be shown by having a student with a germ-laden hand shake hands with fifty clean hands and then show the resulting contamination through the microscope. The home economics department of the university will be represented in the exhibition by a booth showing how to design and fit dresses and how to distinguish between good and bad taste in house decoration and furniture selection.

UNIVERSITY AND EDUCATIONAL NEWS

THE Harvard Graduate School of Applied Science has received from an anonymous donor a gift for a high-tension electrical laboratory. It will be built near the Jefferson Physical Laboratory. It is expected that the laboratory will have at its disposal an alternating current of 1,000,000 volts and a direct current of 100,000 volts.

ANNOUNCEMENT has been made of a gift of \$100,000 by Mr. J. P. Morgan to the Peabody College for Teachers. The trustees of the George Peabody fund have agreed to give an additional \$500,000 to the college, provided it collects \$1,000,000 by September 1, 1913.

Several fellowships in industrial chemistry will be offered by the chemical department of the North Dakota Agricultural College for the coming year. These fellowships, of the value of \$500, will be given for research work in connection with the paint industry.

MR. RUNCIMAN, president of the Board of Agriculture and Fisheries, has announced that in addition to the block grant of £1,300 a year given by the board to University College, Reading, in aid of agriculture and horticulture, and in addition to a further grant of £1,000 a year recently offered to the college in aid of advisory work among farmers, the Board of Agriculture would provide £2,500 a year and one half of the capital cost of a building with the object of establishing a dairying research station at the college, on condition that the grant of \$2,500 a year was supplemented by £1,300 a year provided locally for the purpose.

THE degree of doctor of public health has just been established at the University of Wisconsin by vote of the regents upon recommendation of the university faculty. Candidates for this degree must hold the degree of doctor of medicine from medical schools of approved standing and must have spent at least two years in the study of sciences related to hygiene and public health subsequent to the regular medical course.

PROFESSOR GEORGE P. BURNS, who went to the University of Vermont two years ago as head of the department of botany, will not return to the University of Michigan, from which he had leave of absence.

THE Kaiser Wilhelm professor at Columbia University for the academic year 1912-13, who is nominated by the Prussian Ministry of Public Instruction, will be Phelix Krüger, Ph.D., professor of psychology at the University of Halle.

DISCUSSION AND CORRESPONDENCE

THE USE OF THE WORD "GENOTYPE"

IN a recent issue of *SCIENCE*, Bather¹ takes exception for the third time to the use of the word "genotype" by writers on Mendelism who apply the term in a sense quite different from that in which it was first proposed and has since been used consistently and continuously. It is obvious that Bather is not familiar with the situation here in America or surely he would be less caustic in his remarks. Certain of our biologists have been suffering from an attack of what might be called *Dementia Mendeliana*. Those of us who have escaped infection or who have recovered from the attack but who are surrounded by the sufferers are inclined to refer to their actions "less in anger than in sorrow."

Doubtless it is hard for a foreigner to understand the situation here in America. In biology no less than in politics we have "progressive" elements. And certain of these progressives have taken to themselves a name "geneticists." Also they have evolved a language. In doing this they have appropriated freely from the older language of mathematics, but not without exciting the suspicions of mathematicians. They have likewise appropriated certain terms from biological taxonomy, and since few if any of the leading "geneticists" are more familiar with taxonomy than with mathematics it is not strange that some of the borrowed terms have been misapplied.

There are few mathematicians who are familiar enough with biological matters to realize what liberties have been taken with their language, and few biologists sufficiently mathematical to be disturbed. It remains then for those biologists whose linguistic sensibilities are keen, to be annoyed if not irritated by the misapplication of biological terms in this new language.

But the present outlook is not without its hopeful features. It is to be observed that a movement toward segregation is taking place. The literature of this cult is not so widely

¹ *SCIENCE*, N. S., 35: 270.

scattered as formerly, though its volume remains large. During the last convocation week the American Association for the Advancement of Science was spared somewhat by the fact that most of the geneticists met in a city apart. Thus we venture the hope that in due time the segregation may become so complete that scientists may be free to peruse their favorite journals without risk of that offense to the finer sensibilities which results from seeing familiar words or characters abused.

CARL S. SCOFIELD

LANHAM, MD.,

February 18, 1912

UNIVERSITY REGISTRATION

TO THE EDITOR OF SCIENCE: Information received from the registrar of the University of Nebraska after the university registration statistics printed in the issue of SCIENCE for January 5, 1912, had gone to press, increase the enrollment of that institution as of November 1, 1911, from 2,733 to 3,459, as against 3,661 on November 1, 1910. The decrease is due to the fact that the affiliation relations of the university with the conservatory of music, which had existed for a number of years, were severed during the summer of 1911. The gain in attendance on the other departments was not large enough to offset the loss in music students.

In the net total registration of 4,889 students at Cornell University (excluding the summer session) there were included 477 students in the 1911 short-course in agriculture. These students are not in attendance at the university this academic year, although approximately that number of students are enrolled in the 1912 winter course. If these students are excluded from the Cornell registration, the winter attendance would be 4,412, instead of 4,889.

As for the figures of the University of Minnesota, in connection with which an explanation was given in a footnote, the situation is as follows: It has been customary for a long time to include in the total registration of the university the registration of the *School of Agriculture*, which is to be distinguished

sharply from the *College of Agriculture*, the latter being of collegiate grade, while the school has a three-year course of secondary grade. The students in attendance on the school, therefore, while not technically preparatory students in the sense that they are being fitted for college work, should really be classed as preparatory students—in any event they can not logically be regarded as college students. Subtracting from 4,307 students recorded as being in attendance at the university on November 1, 1911 (including the summer session), the 775 students in the school of agriculture, leaves a balance of 3,532 students of collegiate and university grade.

The figures for the Harvard School (787) included only the students in the summer courses in arts and sciences. There are, in addition, 278 students in science in the summer school of dental medicine. The total summer attendance thus becomes 1,065. Of these 115 students returned for work in the fall, the net total attendance at Harvard, inclusive of the summer session, thus being 5,674 instead of 5,426.

The University of Cincinnati submitted a table showing that its enrollment in all faculties on November 1, 1911, was 1,324 students, as against 1,416 on November 1, 1910, 1,364 on November 1, 1908, and 1,068 on November 1, 1903.

Taking account of these revisions, the net total attendance of 28 American universities as of November 1, 1911, including the summer session, but making due allowance for the summer session students who returned in the fall, is given in the following list.

1. Columbia	7,938
2. California	5,724
3. Harvard	5,674
4. Cornell	5,609
5. Michigan	5,452
6. Chicago	5,390
7. Pennsylvania	5,220
8. Wisconsin	5,015
9. Illinois	4,929
10. New York	4,055
11. Minnesota	3,773
12. Ohio State	3,567

13. Nebraska	3,459
14. Northwestern	3,438
15. Syracuse	3,307
16. Yale	3,224
17. Missouri	2,596
18. Texas	2,539
19. Kansas	2,265
20. Indiana	2,154
22. Iowa	1,967
21. Tulane	2,040
23. Stanford	1,648
24. Princeton	1,543
25. Western Reserve	1,331
26. Cincinnati	1,324
27. Johns Hopkins	1,057
28. Virginia	804

RUDOLF TOMBO, JR.

CONVOCATION WEEK MEETINGS

I HAVE read with interest two recent communications¹ in *SCIENCE* relative to the meeting place of the different scientific societies, with which I am heartily in accord. To me the only valid objection to holding these meetings at the time and place of the American Association is the tendency of the different meetings to conflict with one another. This difficulty should be to a great extent obviated if the executive committees of related societies (for example, zoologists, naturalists, anatomists) were to jointly arrange the program for their societies, allowing this program if necessary to include the day preceding or following those on which the general association meets. Certainly this difficulty was not obviated last year when the three societies above named met at Princeton, the meetings of zoologists and anatomists distinctly conflicting with each other. On the other hand, the great objections, as it seems to me, of holding these meetings at different places and at the same time is the entire loss of the benefits of the general association by those who wish to attend the sectional meetings. Speaking personally, I was much disappointed to miss the Sigma Xi convention at Washington last year in order to attend the zoologists' meeting at Princeton. To one living at some distance

¹ Morse, Max, *SCIENCE*, December 22, 1911.
Reese, A. M., *SCIENCE*, January 12, 1912.

from the heart of things a trip to the annual meetings involves a considerable sacrifice of time and money, and he feels like getting the largest return possible for such sacrifice, which was not possible for all of us with the meetings arranged as they were last year.

If the present policy of aloofness on the part of certain societies be deemed desirable in future, might it not at least be possible to arrange the sectional meetings so as not to conflict with those of the general association?

In the case of a society with eastern and central branches (viz., zoologists), where the majority of the members belong to the former branch, I believe it would be fair to all to hold two eastern meetings to each one in the central district, such meetings to be joint meetings of the two branches. Separate meetings by each branch seem to me undesirable, at least if such meetings are held at the same time, as was the case with the zoologists in 1910.

R. T. YOUNG

UNIVERSITY OF NORTH DAKOTA

THE TIDAL MACHINE

TO THE EDITOR OF *SCIENCE*: The undersigned desires to say that the machine described in the issue of this journal of February 23, 1912, under the name of "The Harris Tidal Machine" is the product of one of the bureaus of this government, the Coast and Geodetic Survey. The officials of that bureau, who are well acquainted with all the details of its development, from first inception to final completion, named it "The Coast and Geodetic Survey Tide Predicting Machine." Under that name it was described briefly in the *Journal* of the Washington Academy of Sciences, July 19, 1911, and more fully, with illustrations, in *Engineering News* of July 20, 1911.

E. G. FISCHER

WASHINGTON, D. C.,
February 26, 1912

REPLYING to Mr. Fischer's note concerning my article on "The Harris Tidal Machine" published in this journal on February 23,

1912, I wish to state that to the best of my knowledge and belief no "christening" of the machine has yet taken place; if it has, I am morally certain that the inventor was not invited to the ceremony. As the title "The Coast and Geodetic Survey Tide Predicting Machine" used by Mr. Fischer is not only lengthy but includes the Ferrell Machine used by the office for many years, the title under which I described it is logical in that it differentiates the Harris Machine from its predecessor, at the same time serving as a mark of honor to its inventor.

I wrote three letters to the Coast Survey Office protesting against the injustice done Dr. Harris in Mr. Fischer's article in *Engineering News* of July 20, 1911, and calling attention to the misstatements contained therein, requesting that the office publish suitable corrective notes. My letters were unanswered and I, therefore, laid the facts before the public in my article.

SAMUEL TIERNEY, JR.

QUOTATIONS

DR. WILEY AND THE BUREAU OF CHEMISTRY

ON the 9th of April, 1883, I took the oath of office and entered upon the discharge of my duties as chief of the Bureau of Chemistry, in the Department of Agriculture. For the past twenty-nine years I have endeavored to discharge these duties according to the dictates of my conscience, the knowledge at my command and the obligations of my oath. In retiring from this position after so many years of service it seems fitting that I should state briefly the causes which have led me to this step. Without going into detail respecting these causes, I desire to say that the fundamental one is that I believe I can find opportunity for better and more effective service to the work which is nearest my heart, namely, the pure food and drug propaganda, as a private citizen than I could any longer do in my late position.

In this action I do not intend in any way to reflect upon the position which has been taken by my superior officers in regard to the same problems. I accord to them the same

right to act in accordance with their convictions which I claim for myself.

After a quarter of a century of constant discussion and effort, the bill regulating interstate and foreign commerce in foods and drugs was enacted into law. Almost from the very beginning of the enforcement of this act I discovered that my point of view in regard to it was fundamentally different from that of any of my superiors in office. For nearly six years there has been a growing feeling in my mind that these differences were irreconcilable, and I have been conscious of an official environment which has been essentially inhospitable.

I saw the fundamental principles of the food and drugs act, as they appeared to me, one by one paralyzed and discredited. It was the plain provision of the act and was fully understood at the time of the enactment, as stated in the law itself, that the Bureau of Chemistry was to examine all samples of suspected foods and drugs to determine whether they were adulterated or misbranded, and that if this examination disclosed such facts the matter was to be referred to the courts for decision.

Interest after interest, engaged in what the Bureau of Chemistry found to be the manufacture of misbranded or adulterated foods and drugs, made an appeal to escape appearing in court to defend their practises. Various methods were employed to secure this, many of which were successful. One by one I found that the activities pertaining to the Bureau of Chemistry were restricted and various forms of manipulated food products were withdrawn from its consideration and referred either to other bodies not contemplated by law or directly relieved from further control.

A few of the instances of this kind are well known. Among these may be mentioned the manufacture of so-called whiskey from alcohol, colors and flavors; the addition to food products of benzoic acid and its salts; of sulphurous acid and its salts; of sulphate of copper; of saccharin and of alum; the manufacture of so-called wines from pomace, chemicals and colors; the floating of oysters often in polluted waters for the purpose of making

them look fatter and larger than really they are for the purpose of sale; the selling of moldy, fermented, decomposed and misbranded grains; the offering to the people of glucose under the name of "corn syrup," thus taking a name which rightfully belongs to another product made directly from Indian corn silks.

The official toleration and validation of such practises have restricted the activities of the Bureau of Chemistry to a very narrow field. As a result of these restrictions, I have been instructed to refrain from stating in any public way my own opinion regarding the effect of these substances upon health, and this restriction has conflicted with my academic freedom of speech on matters relating directly to the public welfare.

These restrictions culminated in the summer of 1911 with false charges of misconduct made against me by colleagues in the Department of Agriculture, which, had it not been for the prompt interference on the part of the President of the United States, to whom I am profoundly grateful, would have led to my forcible separation from the public service. After the President of the United States and a committee of Congress, as a result of investigation, had completely exonerated me from any wrongdoing in this matter, I naturally expected that those who had made these false charges against me would no longer be continued in a position which would make a repetition of such action possible. The outcome, however, has not sustained my expectations in this matter. I was still left to come into daily contact with the men who secretly plotted my destruction.

I am now convinced that the freedom which belongs to every private American citizen can be used by me more fruitfully in rallying public opinion to the support of the cause of pure food and drugs than I could with the limited activity left to me in the position which I have just vacated. I propose to devote the remainder of my life, with such ability as I may have at my command and with such opportunities as may arise, to the promotion of the principles of civic righteousness and industrial integrity, which underlie

the food and drugs act, in the hope that it may be administered in the interest of the people at large, instead of that of a comparatively few mere manufacturers and dealers.

This hope is heightened by my belief that a great majority of manufacturers and dealers in foods and drugs are heartily in sympathy with the views I have held and that these views are indorsed by an overwhelming majority of the press and the citizens of the country. In severing my official relations with the Secretary of Agriculture I take this opportunity of thanking him for the personal kindness and regard which he has shown me during his long connection with the department. I can not leave the Bureau of Chemistry without expressing to my assistants of all grades my appreciation of their loyalty and devotion to me.—Statement by Dr. H. W. Wiley.

SCIENTIFIC BOOKS

A Descriptive Catalogue of the Higher Groups, Genera, Species and Subspecies of Birds known to occur in North America, from the Arctic Lands to the Isthmus of Panama, the West Indies and other Islands of the Caribbean Sea, and the Galapagos Archipelago. By ROBERT RIDGWAY, Curator of the Division of Birds. Part V. [Containing] Family Pteroptrochidæ—The Tapacolas. Family Formicariidæ—The Antbirds. Family Furnariidæ—The Ovenbirds. Family Dendrocolaptidæ—The Woodhewers. Family Trochilidæ—The Humming Birds. Family Micropodidæ—The Swifts. Family Trogonidæ—The Trogons. Washington: Government Printing Office. 1911. Bulletin of the United States National Museum. No. 50. Part V. "Issued November 29, 1911." 8vo. Pp. xxiii + 859; pls. xxxiii.

Part V. of Ridgway's monumental work on the birds of north and middle America completes the first two thirds of this great undertaking, Part I. of which appeared in October, 1901. As Part IV. was issued in 1907, a longer interval than usual has elapsed between the appearance of Parts IV. and V., due in

part to interruptions by field work and illness, and in part to the preparation of matter originally intended, and even put in type for the present volume, but which it was found would too greatly increase its size. This matter, embracing the large family of Woodpeckers, will appear in Part VI., now in an advanced stage of preparation.

The present volume includes seven families, five of which are exclusively American, four of them being very numerous in species and subspecies. These are the Pteroptochidæ (with only one species in the geographical area of the present works), the Formicariidæ (66 species and subspecies), the Furnariidæ (29 species and subspecies), the Dendrocolaptidæ (41 species and subspecies) and the Trochilidæ (174 species and subspecies). The other two families included are the Micropodidæ (25 species and subspecies) and the Trogonidæ (23 species and subspecies), the first of wide distribution throughout the world, the other common to all tropical regions. The same careful treatment in respect to technical details that has characterized the previous volumes is still maintained, as are the bibliographic references, which give at a glance the history of the species and higher groups as treated by preceding authors. The "keys" include many extra-limital genera and species, thus greatly widening the scope of the work as announced on the title page. There is a tendency to recognize as genera many groups usually treated as subgenera or altogether ignored; they are as a rule natural groups and their recognition in nomenclature is consistent with the present almost universal tendency to differentiate slight geographical forms as worthy of recognition as subspecies.

As heretofore, the work is based upon the material of the United States National Museum plus that of all the principal collections, private as well as public, in this country, the specimens examined in preparing the present volume numbering 14,358, of which about 6,000 are in the joint collections of the National Museum and Biological Survey. Of the more than 8,000 borrowed specimens, nearly all were furnished by three institutions,

the Museum of Natural History in New York, the Museum of Comparative Zoology at Cambridge and the Carnegie Museum of Pittsburgh. Through this system of cooperation the leading museums are benefited as well as the author, since the loaned material is returned bearing the identifications of the leading expert on the subject, and in addition the results of the author's investigations as here set forth are more comprehensive and rest on a firmer basis than would otherwise be possible. With even these resources the author has to regret that in several of the families a number of genera and very many species were not available for examination, so his "effort to bring order out of chaos can be considered as only partially successful."

While the scope of the work is restricted to the technicalities of the subject, references are made to nests and eggs "where some particular style of nest or coloration of eggs is characteristic of a group (family or genus), as a sort of accessory or supplemental group character." A paragraph is also given in the description of each family to a statement respecting the range in size, character of plumage, manner of life and nature of the food of the species, as well as their number and geographical distribution. Thus under the family Trochilidæ are some items of information not generally known even to all ornithologists, and much less to the general reader.

"Inhabitants exclusively of America, the Humming Birds constitute not only the most charming element in the wonderfully varied bird-life of the Western Hemisphere, but, also, without doubt, the most remarkable group of birds in the entire world. No other group of birds is so brilliant in plumage or so different from all others in their mode of flight and manner of feeding. The general habits of Humming Birds are not dissimilar to those of birds in general. They are both aerial and arboreal, but are unable to progress upon the ground or any flat surface by means of their legs and feet alone. They perch readily and frequently upon trees or bushes, or may even cling to rocks or other vertical surfaces; and

their nidification presents nothing that may be deemed peculiar or even specially characteristic. In their flight and manner of procuring their food, however, they differ strikingly from all other birds, in these respects closely resembling certain insects, especially the crepuscular hawkmoths (Sphingidae). Their food, consisting mainly of small insects, but in part also of the nectar of flowers, is mostly gleaned from blossoms, before which they poise, with wings so rapidly vibrating as to be invisible except as a dim haze or halo partly surrounding the body and producing the humming sound from which these birds derive their vernacular name, the bill thrust inside the flower and the slender, semitubular tongue extended into the depths of the blossom. Some species, instead of feeding from flowers, glean their insect food from the bark of forest trees, following along the branches in suspended flight in the same manner that the others pass from flower to flower. In their feeding from flower to flower, Humming Birds, like bees, butterflies, and moths, perform the same office in the economy of nature as insects by transferring pollen from one bloom to another, and thus assisting in the fertilization of plants. In flying from one point to another, the flight of Humming Birds, while essentially direct, is usually more or less undulating, and so extremely rapid that the eye can scarcely follow. Often this flight is accompanied (at least in the case of males of some species) by a more or less remarkable screeching or grating sound, produced mechanically by some peculiarity of wing-structure.

"Diminutiveness of size and metallic brilliancy of coloring are the chief external characteristics of Humming Birds, though exceptions to both occur; and in these respects they, as a group, have no rivals. Unfortunately, stuffed specimens convey but a faint idea of their splendid coloring, for the perfection of their changeable refulgence can be fully realized only in the living bird, whose every change of position flashes to view a different hue—emerald green replacing ruby red, sapphire blue succeeding fiery orange, or either becoming opaque velvety black—according to

the angle at which the sun's rays touch the feathers, an effect which can only partially be imitated with the stuffed specimen by artificially changing its position with reference to the light. Many species have a spot of the most luminous or brilliantly metallic color (usually green) that it is possible to imagine on the forehead at the base of the bill, this spot being surrounded by the most intense velvety black—evidently to enhance the brilliancy of the ornament by contrast, just as a jeweler would, for the same purpose, display a diamond or other gem against a background of black velvet. Often there is a spot of brilliant color and one of a contrasting hue just below it, the result being that first one color, then the other, is flashed forth as the bird changes slightly its position."

The thirty-one plates give the structural details of bill, wings, tail and feet of each of the 121 genera, thus greatly facilitating identification. It is hoped that Part V. may be followed in due time by the remaining volumes of this invaluable work, so indispensable to all students of American birds.

J. A. ALLEN

The Hindu-Arabic Numerals. By DAVID EUGENE SMITH and LOUIS CHARLES KARPINSKI. Boston and London, Ginn and Company. 1911. Pp. vi + 160.

This book gives in compact form a readable and carefully prepared account of the numerous researches which have been made in the endeavor to trace the origin and development of the Hindu-Arabic numerals. Teachers of mathematics will welcome it, while students specializing in the history of mathematics will derive great help from the many bibliographical references to other publications on this subject. Like the arithmetician Tostall the authors read everything in every language and spent much time in licking what they found into shape *ad ursi exemplum*, as the bear does her cubs. But it would not be a correct statement, were we to convey the idea that the book does not embody original research. In several cases the authors have been able to correct mistakes of earlier writers

and to add results of their own research. In a few instances this history appears to us incomplete and defective. This we shall endeavor to show in what follows.

The authors very properly give much attention to the study of routes of commercial travel. There is every reason to believe that the migrations of the numerals took place along commercial routes. The authors consider the possibility of an early influence of China upon India; they speak of trade routes and the interchange of thought by land and sea, between countries bordering on the Mediterranean and far-off India. They even point out early relations of Greece with China. In view of these careful studies it is singular that practically nothing should be said on the intercourse which did or did not exist between Babylonia and India during the centuries immediately preceding and following the beginning of the Christian era. They ignored a question which lies at the root of present-day speculations on the earliest traces of the principle of local value and the symbolism for zero. Of course, local value is considered by the authors in connection with the Hindu-Arabic numerals. Not to do so would be to examine the shell and ignore the kernel. Were these fundamental notions wholly of Hindu origin or were the rudimentary ideas relating to them imported into India from neighboring territory? In the book under review this vital question is not adequately discussed. The authors are correct in stating that the preponderance of authority has been in favor of the hypothesis that our numeral system, with its concept of local value and our symbol for zero has been of Hindu origin. But this conclusion is coming to be recognized as unsafe. The change of opinion that is taking place is voiced by two German authors of brief histories, Tropicke and Günther. In 1902 Tropicke said¹

Dass unser Positionssystem mit seinen Ziffern indischen Ursprunges ist, steht fest.

¹ "Geschichte der Elementar-Mathematik," I., p. 10.

In 1908 Günther said²

Man kann . . . sich den Vorgang vielleicht so denken, dass Indien von Babylon her die ersten schwachen Andeutungen des Stellenwertes empfing, sie in seiner Weise um- und ausbildete und später das reiche Geschenk des fertigen Positionssystems den Nachkommen jener Geber zurückerstattete.

The evidence in favor of a possible Babylonian origin is even stronger than as stated by Günther, for he was apparently unaware that symbols for zero had been found in Babylonia. These symbols are mentioned, but not adequately discussed by Smith and Karpinski, on page 51. The facts in our possession to-day are about as follows:

1. Two early Babylonian tablets, one probably dating from 1600 or 2300 B.C., use the sexagesimal system and the all-important principle of local value. It so happens that they contain no number in which there was occasion to use a zero.

2. Babylonian records from the centuries immediately preceding the Christian era give a symbol for zero which was apparently "not used in calculation." It consisted of two angular marks, one above the other, roughly resembling two dots, hastily written.

3. About A.D. 130, Ptolemy in Alexandria used in his "Almagest," the Babylonian sexagesimal fractions and also the omicron O to represent blanks in the sexagesimal numbers. The symbol was not used as a regular zero.

4. Strabo and others have described the trade routes by land and the trade between Babylonia and India, also the trade by sea.

5. Sexagesimal fractions were used by Hindu astronomers. Historians do not deny that the Indian sexagesimal fractions were of Babylonian origin.

6. The earliest form of the Indian symbol for zero was that of a dot, which, according to Bühler, was "commonly used in inscriptions and manuscripts in order to mark a blank." This early use of the symbol resembles somewhat the still earlier use made of symbols for zero by the Babylonians and by Ptolemy. Probably Aryabhata, in the fifth century

² "Geschichte der Mathematik," I., p. 17.

A.D., knew our zero. The earliest undoubted occurrence of our zero in India is in 876 A.D.

Were there overflows of Babylonian science into Greece and India? The question is pertinent. The possibility of overflows into India has been recognized not only by Günther, but by Nallino, who states that the Chaldeans of 100 B.C. (and even earlier) knew the sidereal year (estimated at 365 d. 6 hr. 13 m. 43 sec.) and that this knowledge probably passed from them to the Hindus and Persians. This statement is quoted by H. Suter with apparent approval.³ It seems to us that these facts point directly toward a summary of the case, somewhat as quoted above from Günther.

In recounting the earliest uses made of the Arabic numerals in Egypt and the Occident, reference is made to a trace on a pillar of a church in Egypt, giving the date 349 A.H. (=A.D. 961). Strange to say our authors completely ignore similar evidence, as given in the *Philosophical Transactions* of London. Why should this be? No less prominent a mathematician than John Wallis arrived at the conclusion that "their use in these parts was as old at least as . . . the middle of the eleventh century."⁴ Wallis refers to the "Mantle-tree of the Parlour Chimney at the dwelling House of Mr. Will. Richards, the Rector of Helmdon in Northampton-shire," bearing an inscription with the date "A° Do! M° 133" (=A.D. 1133). Thomas Luffkin⁵ names a building in Colchester bearing the date 1090. These dates are of interest to an Englishman or an American. If they are to be rejected, it would seem that the reasons therefor should be set forth in a publication aiming to weigh minutely all respectable evidence. Smith and Karpinski make no mention of an earlier use than 1539 of the numerals in Great Britain.

In describing the different shapes of the

³"Bibliotheca Mathematica," Vol. 5, 1904, p. 85.

⁴*Philosophical Transactions*, No. 154, p. 399 (=Abridgment, Vol. I., 1705, p. 107).

⁵*Philosophical Trans. Abridged*, Vol. I., 1705, p. 198.

zero in Europe the authors overlooked the curious use of *theta* θ to represent zero, found in the writings of Michel Rolle, and Eneström's note on this notation in "L'Intermédiaire des mathématiciens," II., 1895, p. 283.

It has been said of early American geologists that they crossed the western plains, eager to reach the Rocky Mountains, there to grapple with the problems relating to the geology of our land, that in so doing they neglected the geologic problems presented by the plains themselves. In the same way our authors hastened back half a thousand years to reach the conspicuously formative periods, and in so doing they forgot to take note of matters of interest connected with recent time, which for historical research is far from barren. Our authors note the different shapes which the numerals assumed among the Hindus, Arabs and Europeans of the Renaissance. But if I mistake not, interesting forms, worthy of study, are found in seventeenth and eighteenth century manuscripts, stored away in American libraries. It is of some interest that the figure 8 sometimes had the shape of our dollar mark written with a single downward stroke, thus, \$. I remember mistaking such an eight for a dollar mark and recognizing my error only when the sum given in the manuscript would not come out as represented, except on the supposition that the mark stood for 8. The authors point out anomalous combinations of the Hindu-Arabic and the Roman numeral symbols which occurred more or less accidentally in the fifteenth and sixteenth centuries, but they fail to notice a curious combination which occurs with surprising regularity in Spanish-American manuscripts during the three centuries preceding the beginning of the nineteenth century. Of this notation we shall speak in a separate article.

On page 28, line 10, the word "vertical" should be replaced by the word "horizontal." In the table of contents there is an omission such that the pronoun "their" in the line "Early ideas of their origin" refers to

"oriental names"; it should refer to "Hindu-Arabic numerals." The alphabetical index is not as complete as one might wish it to be.

FLORIAN CAJORI

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A Laboratory Course in Physiology. By WALTER B. CANNON, A.M., M.D., George Higginson professor of physiology in the Harvard Medical School. Second edition. Published by Harvard University. 1911.

This is the set of loose-leaf laboratory notes and directions used in the course in physiology in the Harvard Medical School. It belongs to a class of works which have only begun to appear in recent years. It is not a general laboratory manual like the well-known handbook of Burdon Sanderson, or that of Stirling. Its scope is much narrower. While these works aimed to give, within the limits of their size, accounts of all ordinary physiological methods, the work before us, on the contrary, is merely a precise description of a particular course. Accordingly, it is limited to such methods as the facilities of the Harvard School allow. Within these limitations, however, it is excellent. It has already been adopted as the basis of the physiological course in a number of other institutions and contains much that is valuable and suggestive for the teaching of physiology anywhere.

The most striking defect of this "course" is that it contains far too much of the physiology of the frog and too little of the mammal. For the medical student direct personal experience in working with the circulation in one living cat or dog is worth two or three experiments upon the frog's heart, and a dozen upon the frog's leg. It is most unfortunate that the limitations which misguided humanitarians and anti-vivisectionists place upon the supply of cats in Boston should make it necessary to have the circulation in this animal worked out by the students in groups of twelve. This certainly falls far short of the important educational principle urged by Pearce that "the students should do it themselves." The reviewer knows from

personal experience that the largest number of students who can possibly take part in a blood-pressure experiment on one cat is five. If mammalian material were as abundant as it ought to be for such a course, the work on the frog here outlined could profitably be cut in half. Each group should number four or five students instead of twelve and should have, instead of one cat, six to ten.

Much of the work on the frog here given could be profitably replaced by experiments on man. Simple sphygmomanometers can be provided cheaply, and should be used for experiments on the students themselves on a much more extensive scale than is outlined in these notes.

The weakest point in the notes is the section on respiration. Only eight pages are devoted to this subject, while muscle nerve physiology receives eighteen. The progress in knowledge of respiration within recent years, for which we are indebted principally to Haldane and his pupils, has been made largely by experiments upon man. These experiments are ideally suited to a laboratory course. Among them may be mentioned that of voluntary forced breathing and the succeeding apnoea; that of the artificial production of Cheyne-Stokes breathing requiring for its demonstration merely a tin of soda lime and a long tube; and that of the duration of the voluntary holding of the breath without preparation, after forced breathing, after oxygen and after forced breathing and oxygen.

These, however, are merely criticisms of detail. In general this work is certainly by far the best of its kind that has yet appeared. No other educational institution in America, perhaps none in the world, in recent years has made so many valuable experimental contributions to the theory and methods of teaching as has Harvard. Among these contributions not the least valuable is the demonstration that science in general and physiology in particular can be, and ought to be, taught by laboratory methods. Originally conceived by Huxley and first practised in this country by Newell Martin at Johns Hopkins and by the

late Professor Bowditch at Harvard, this idea has finally developed in the hands of the latter's successor into the work before us. It has the particular merit of making available everywhere the results of twenty years of experience in the teaching of physiology at the Harvard Medical School.

YANDELL HENDERSON

YALE MEDICAL SCHOOL,
NEW HAVEN, CONN.,
February 27, 1912

PLEISTOCENE MAN FROM IPSWICH
(ENGLAND)

So much has been said in the public press concerning a human skeleton of reputed great antiquity recently found near Ipswich, England, that a request from the editor of SCIENCE alone sufficed to cause me to alter my original decision not to write anything on the subject until after I had seen the skeleton as well as the locality from which it came. On receipt of communications from Mr. J. Reid Moir, who found the remains and from Professor Keith, who is making a detailed study of them, it is possible for me to comply with the request without further delay.

The main facts are these. On October 6, 1911, Mr. J. Reid Moir, of Ipswich, was notified by Messrs. Bolton and Laughlin, local brickmakers, that one of their workmen, while removing surface clay to reach the underlying glacial gravel, had encountered human bones. Mr. Moir proceeded at once to the pit and found that a portion of a human skull still attached to a complete encephalic cast of boulder clay had been recovered. Recognizing the importance of the find, Mr. Moir removed the remainder of the skeleton in the presence of three gentlemen, Messrs. Woolnough (curator of the local museum), Canton, and Snell. In order to preserve the extremely fragile bones, the containing beds were removed with them. After this had been done, three geologists, Dr. J. E. Marr, F.R.S., Mr. W. Whitaker, F.R.S., and Mr. George Slater, F.G.S., were called to Ipswich to examine the section.

A sheet of hard chalky boulder clay of vary-

ing thickness is spread over East Anglia, overlying stratified mid-glacial sands. Between these deposits and at a depth of only four and one half feet the skeleton was found. Was it interstratified? This question will probably never be answered to the satisfaction of all. According to Mr. Moir, a "most careful examination of the section before the disinterment took place showed clearly that no signs of any previous digging were visible, the clay above the skeleton appearing to be in every way the same as that which extended for some distance on each side of it." The presence of a calcareous band immediately underneath the skeleton was noted as well as the fact that it "extended more or less continuously on either side of the spot where the remains were found"; and it is pointed out by Mr. Moir that if a grave had been dug through the boulder clay, rain water percolating through the loose grave filling would have dissolved away the calcareous deposit. One of the best bits of evidence is that the skeleton was partly embedded in glacial sand and partly in boulder clay; "this sand showed clearly lines of stratification and was conformable with that underlying it."

On the other hand Mr. George Slater, one of the three geologists called to view the place, but not until after the bones had been removed to London, looks upon the site as highly unsatisfactory. Considering the loss by infiltration he would not expect to find distinct signs of a grave after a lapse of some thousands of years. The position on the side of a valley points to the possibility of hill wash or re-deposited boulder clay.

It was a wise precaution from every point of view to remove the matrix with the skeleton. This was done in blocks which were forwarded to Professor Arthur Keith at the Museum of the Royal College of Surgeons, London. Here each block was impregnated with a solution of gelatine, after which the bones were exposed by piecemeal removal of the overlying boulder clay, but were still left in situ on the underlying glacial sands. According to Professor Keith the whole skeleton was represented, its various parts being in

their proper position one to the other. It rested on its right side with the head bent forward, so as almost to reach the knees. The right arm was flexed beneath the body, the right hand resting under the right leg. The left arm was even more acutely flexed, with the elbow gripped between the knees and the left hand turned against the left shoulder. That the position of the Ipswich skeleton resembled somewhat the contracted posture so common to neolithic burials was recognized by Professor Keith, who believes, however, that this position does not necessarily mean burial; in other words, that it could have been assumed by the body at death without the intervention of intentional forces.

The right side of the skeleton in contact with the glacial sands was much better preserved than the left. The latter being embedded in the boulder clay, was most subjected to the destructive effects of roots as well as the action of the clay itself. The roots even penetrated the glacial sands and their effects on the skull and pelvis were marked. The corroding effects of the boulder clay (sandy, chalky loam) played havoc with the soft spongy portions of the skeleton, which are now represented by dense clay with here and there fragments of bone. The only complete bones recovered were those of the right hand.

The skeleton is that of a man about five feet ten inches in height and forty to fifty years of age. In addition to the complete brain cast (of boulder clay) there remain a "fragment of the frontal bone sufficient to show the characters of the forehead, parts of both temporal bones, with the joints of the mandible, and fragments of the parietal and occipital bones."¹ Nine of the teeth were recovered; these differ in no way from the teeth of neolithic man. Judging from the skull fragments and the brain cast, Keith concludes that the head did not differ essentially from that of modern Europeans except that the

maximum width of the skull is situated rather far back, recalling in this respect alone the Neanderthal race. With the exception of the lower leg bones (tibia and fibula) and the upper arm bone or humerus, the limb bones are of the modern European type. The tibia lacks the sharp anterior crest or shin of modern man, and in this suggests the Neanderthal type, but not in respect to size and general shape.

If the skeleton does not represent a burial and if the chalky sandy loam at this point is a part of the original mantel of boulder clay, then the man of Ipswich is the earliest yet found with the exception of *Homo heidelbergensis* (*Pithecanthropus* not being considered as *Homo*). It would correspond to the latest eolithic horizon, the so-called Mesvinian, and would thus be somewhat older than the man of Galley Hill, provided the latter is properly dated. But as I pointed out in a recent article² there is room for doubt as to the age of the Galley Hill skeleton. From the foregoing account it would seem that the age of the Ipswich skeleton is also still an open question. The importance of having expert witnesses present at the disinterment in discoveries of this class was perhaps never better exemplified than at Galley Hill and Ipswich. Their absence will, it is feared, always leave the shadow of a doubt as to the age of the skeletons in question; and doubt is a serious handicap in matters of such scientific import. If both these specimens are correctly dated, then there lived as contemporaries in Europe for a long space of time two somatologically distinct races—a primitive type represented by the Mauer mandible, Neanderthal, Spy, Chappelle-aux-Saints, La Quina, etc.; and a modern type represented by Ipswich, Galley Hill, and possibly Bury St. Edmunds. This is by no means impossible, in fact might have been the case. Either Ipswich or Galley Hill would alone be sufficient to prove it so, if all doubt as to age were removed. Until the full reports of Professor Keith, Mr. Moir, and the three geologists have been published, final

¹From the report of an "inquest" in Ipswich February 21, which according to Mr. Moir gives "a very good account of the human remains" he had found.

²"Somatology and Man's Antiquity," *Records of the Past*, X., 329, November-December, 1911.

judgment on the Ipswich case must of course be suspended. If the modern type of man did actually live in Mindel-Riss interglacial times, a Pliocene chipper of flint would certainly not look out of place.

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THIRD LIST OF GENERIC NAMES FOR THE
"OFFICIAL LIST OF ZOOLOGICAL
ICAL NAMES"

9.¹ The following generic names of animals reported as parasites of man have been submitted to the International Commission on Zoological Nomenclature, by the Helminthological Society of Washington, for inclusion in the "Official List of Zoological Names":

CESTODA:

- Davainea* R. Blanchard & Railliet, in R. Bl., 1891t, 428-440, type *proglottina* (in chickens; France).
Diplogonoporus Lænnberg, 1892a, 4-16, type *balænoptera* (in *Balænoptera borealis*; Finmarken).
Dipylidium Leuckart, 1863a, 400, type *caninum* (in dogs; Europe).
Echinococcus Rudolphi, 1801a, 52-53, 55, type *granulosus* (in sheep; Europe).
Tænia Linnæus, 1758a, 819-820, type *solium* (in *Homo*; Europe).

NEMATODA:

- Ancylostoma*² [Dubini, 1843a, 5-13] emendation Creplin, 1845a, 325, type *duodenale* (in *Homo*; Italy).
Ascaris Linnæus, 1758a, 644, 648, type *lumbrioides* (in *Homo*; Europe).
Dracunculus "Kniphof, 1759, 12" [not verified]; Gallandat, 1773a, 103-116, type *medinensis* (in *Homo*).
Gnathostoma Owen, 1836f, 123-126, type *spinigerum* (in *Felis tigris*; London).
Necator Stiles, 1903y, 312, type *americanus* (in *Homo*; U. S. A.).
Strongyloides Grassi, 1879f, 497, type *intestinalis*=*stercoralis* (in *Homo*).
Trichostrongylus Looss, 1905o, 413-417, type *retortaeformis* (in *Lepus timidus*; Europe).

¹ Paragraphs are numbered continuously with the earlier lists.

² See Art. 19, and Opinions 26, 27, 34 and 36.

GORDIACEA:

- Gordius* Linnæus, 1758a, 644, 647, type *aquaticus* (free; Europe).
Paragordius Camerano, 1897g, 368, 399-402, type *varius* (free; U. S. A.).

ACANTHOCEPHALA:

- Gigantorhynchus* Hamann, 1892d, 196, type *echinodiscus* (in *Myrmecophaga jubata*, M. bivittata; Brazil).

10. The undersigned secretary presents the following generic names for definite rejection from the "Official List," on the ground that they are preoccupied (see Art. 34):

TREMATODA:

- Acanthocephala* Dies., 1858, not Laporte, 1832.
Acrodactyla Staff., 1904, not Hal., ante 1846.
Anadasmus Looss, 1899, not Walsingham, 1897.
Anisogaster Looss, 1901, not Deyr, 1863.
Astia Looss, 1899, not Koch, 1879.
Baris Looss, 1899, not Germ., 1817.
Brachymetra Stoss., 1904, not Mayr, 1865.
Creadium Looss, 1899, not Vieill., 1816.
Crossodera Duj., 1845, not Gould, 1837.
Eurycalum Brock, 1886, not Chauder, 1848.
Eurysona Duj., 1845, not Gistel., 1829.
Leioderma Staff., 1904, not Will.-Suhm, 1873.
Leptalea Looss, 1899, not Klug, 1839.
Leptosoma Staff., not Leach, 1819.
Levinsonia Stoss., 1899, not Mesnil, 1897.
Macraspis Olss., 1868 or 1869, not McL., ante 1835.
Megacetes Looss, 1899, not Thomas, 1859.
Microscapha Looss, 1899, not LeConte, 1866.
Polyorchis Stoss., 1892, not Agassiz, 1862.
Polysarcus Looss, 1899, not Fieb., 1853.
Spathidium Looss, 1899, not Duj., 1841.
Stomylus Looss, 1899, not Fahræus, 1871.

NEMATODA:²

- Acanthophorus* Linst., 1876, not Serv., 1832.
Acanthosoma Mayer, 1844, not Curt., 1824.
Aspidocephalus Dies., 1851, not Motsch, 1839.
Brachynema Cobb, 1893, not Fieb., 1861.
Cephalacanthus Dies., 1853, not Lac, 1802.
Cephalonema Cobb, 1893, not Stimps, ante 1882.
Chætosoma Claparède, 1863, not Westwood, 1851.
Cheiracanthus Dies., 1838, not Agassiz, 1833.
Cochlus Zed., 1803, not Humph., 1797.
Conocephalus Dies., 1861, not Thunb., 1812.

² This list contains a few names of organisms which are not Nematoda, but which have been classified as such at one time or another.

Cystocephalus Rail., 1895, not Léger, 1892.
Diceras Rud., 1810, not Lam., 1805.
Dipeltis Cobb, 1891, not Pack., 1885.
Discophora Vill., 1875, not Boisd., 1836.
Eucamptus Duj., 1845, not Chevr., 1833.
Eurystoma Marion, 1870, not Raf., 1818.
Fimbria Cobb, 1894, not Bohadsch, 1761.
Hoplocephalus Linst., 1898, not Cuv., 1829.
Leptoderes Duj., 1845, not Serv., 1839.
Litosoma Ben., 1873, not Douglas & Scott, 1865.
Mitrepheorus Linst., 1877, not Schoenherr, 1837.
Oxyzona Schneid., 1866, not Gerv., 1849.
Ozystoma Buetschli, 1874, not Dum., 1806.
Ozyurus Lam., 1816, not Raf., 1810.
Paradoxites Lindem., 1865, not Goldf., 1843.
Pelodytes Schneid., 1860, not Fitz., ante 1846.
Pterocephalus Linst., 1899, not Schneid., 1887.
Ptychocephalus Dies., 1861, not Agassiz, 1843.
Rhabdogaster Metschnikoff, 1867, not Loew., 1858.
Rhabdonema Leuck., 1883, not Kuetzing, 1844.
Rhabdonema Perr., 1886, not Kuetzing, 1844.
Rhytis Mayer, 1835, not Zed., 1803.
Spilophora Bast., 1865, not Bohem., 1850.
Spirifer Linst., 1901, not Raf., 1831.
Spira Bast., 1865, not Brown, 1838.
Spirura Dies., 1861, not E. Bl., 1849.
Trichina Owen, 1835, not Meig., 1830.
Trichoderma Greef, 1869, not Steph., 1835.
Trichodes Linst., 1874, not Herbst, 1792.
Triodontus Looss, 1900, not Westwood, 1845.
Tropidurus Wieg., 1835, not Neuwied, 1824.
Tropisurus Dies., 1835, not Neuwied, 1824.

GORDIACEA:

Paragordius Montgomery, 1898, = Camerano, 1897.

ACANTHOCEPHALA:

Arhynchus Shipley, 1896, not Dejean, 1834.
Neorhynchus Ham., 1892, not Selater, 1869.

11. The names in question are published for the information of all persons interested. Objection to the proposed action should be filed with the undersigned secretary not later than January 1, 1913, together with ground upon which objection is based.

12. The above names will be forwarded immediately to the International Commission on Medical Zoology, and to the special sub-committees in the groups in question for special report.

13. The list will be forwarded about July 1, 1912, to the International Commission on

Zoological Nomenclature, and the secretary expects to call for a vote on these names at the next regular meeting of the commission, in the summer of 1913.

14. The secretary takes this opportunity to state that his policy is to bring into the list a number of names upon the adoption of which no difference of opinion seems to exist, and to reject a large number of preoccupied names, before he submits for study the names upon which differences of opinion are expressed by authors.

C. W. STILES,

on Zoological Nomenclature
 Secretary International Commission

SPECIAL ARTICLES

ON THE ORIGIN OF A PINK-EYED GUINEA-PIG WITH
COLORED COAT¹

THE rediscovery of Mendel's law in 1900 with the immediate and striking verifications which it received from both animal and plant breeders gave great impetus to the mutation theory of De Vries, and secured wide acceptance of the idea advanced earlier by Galton and Bateson that new organic forms arise only as discontinuous variations, in the production of which continuous or fluctuating variations have no part. An extreme form of this idea has been ably advocated by Johannsen in his pure-line conception of heredity. This has met with a reception so hearty that it is now endangered chiefly by the zeal of its adherents, who seem to some of us to be carrying the doctrine to ridiculous lengths. They can see nothing but pure lines in heredity of any sort; selection is wholly rejected except as an instrument for the sorting out of genes. Possibly this is the correct interpretation of the action of selection, but if so it will be found necessary to invoke the existence of multiple and subsidiary genes to such an extent that continuous and discontinuous variation will become practically indistinguishable. I am inclined, therefore, to question the validity of

¹ In the investigation described in this paper the author was aided by a grant from the Carnegie Institution of Washington, for which grateful acknowledgment is here made.

a hypothesis which has to be carried to such lengths, and I think this view is shared by many whose experience in breeding work has been very extensive.

Webber has somewhere expressed the view, I am sure verbally and I think also in his publications, that sport variation is more likely to occur in connection with repeated selection and in the same general direction as the selection. This view, if correct, is highly important. A case which may be considered to support it has recently occurred in the breeding experiments in progress at the Bussey Institution.

In mice, rabbits and cats, a dull black variety occurs which is known by fanciers as blue. The optical effect called blue is in such cases the result of a diminished number of black pigment granules in the fur. Fanciers have long desired to obtain a similar variety among guinea-pigs, but thus far without much success. Some eight years ago I became interested in the problem and began experiments which have continued to the present time. Knowing that Andalusian blue fowls are heterozygotes of black and white, I tried to produce a similar modification in guinea-pigs by cross-breeding. I found that crossing black with white gave results which varied in character with the white strain used. A sooty or "Himalayan" albino strain which by other experiments was shown to transmit intense black pigmentation produced no diminution of black in the heterozygotes. A very lightly pigmented albino which was found to transmit light yellow ("cream") in crosses produced heterozygotes with a much duller black, but not of the desired blue tone. In other words, albinos in crosses with black were found to breed exactly like the colored strains from which they were extracted. As the cross with a cream strain had produced the lightest black animals thus far obtained, I confined my further experiments to crosses with this cream strain or with albinos derived from it. In each generation the lightest heterozygous blacks were crossed with the lightest creams (or albinos). By this process a very considerable reduction in the amount

of pigment in the fur was secured. The hairs of the black individuals were now dull black at the tip only; elsewhere the hair was sooty cream colored, indicating a great quantitative reduction of the pigments, both black and yellow. These peculiar black individuals we may for convenience henceforth call "blue." Blue parents mated with cream ones have in the past two years produced 17 blue, 15 cream and 13 white young, the Mendelian expectation being 3 blue: 3 cream: 2 white, if all parents are heterozygous for albinism. In a mating of this sort a few weeks ago (December 2, 1911) a blue mother gave birth by a cream male to a female young one which closely resembles an albino, its coat being in general white and its eyes pink, but on the right side of its head and on the hips are spots of blue. As in the pink-eyed mouse, the color of the fur is decidedly pale. In the iris of each eye may also be seen a faint pigmented streak. It is noteworthy that the pink-eyed mouse also has traces of pigment in its eyes.

The genetic behavior of pink-eyed mice shows that the pink-eyed variation is due to modification (or partial loss) of some factor necessary for the production of the full pigmentation. This factor, however, is not the color factor (*C*) which albinos lack, nor the yellow (*Y*), brown (*Br*) or black (*B*) factors, nor yet the agouti (*A*) factor, since with each of these and without it the pink-eyed variation may form distinct combinations. For the same reason it can be shown to be distinct from the condition of spotting with white.

It is noteworthy that the race of guinea-pigs in which the pink-eye variation has appeared is one in which a reduction of the amount of pigmentation was being attempted by a systematic selection, and was being actually obtained. The pink-eye variation would seem, therefore, to be merely a particular long step in the general course of modification which this race was undergoing directed by artificial selection. If so, it has probably been brought about by the modification of the same color factor or factors that have undergone modification in the blue race. This idea

will be put to an experimental test. If found correct, the suggestion will offer itself that a causal relationship may possibly exist between the *little* steps taken under selection, and the longer one appearing as a mutation.

The variation described in this paper made America on a collecting expedition. My associate, Mr. C. C. Little, was then in charge its appearance during my absence in South of the experiments. He at once recognized the importance of the variation from a theoretical standpoint and has given especial care to its preservation. For this I wish both to thank and to congratulate him. A less discriminating observer might easily have mistaken this animal for an albino with soiled fur.

W. E. CASTLE

LABORATORY OF GENETICS,
BUSSEY INSTITUTION,
FOREST HILLS, MASS.,
February 8, 1912

**THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE
SECTION B—PHYSICS**

THE annual meeting of Section B of the American Association for the Advancement of Science was held with the American Physical Society at the Bureau of Standards, Washington, December 27-30, 1911. Four forenoon sessions and three afternoon sessions were held. Of these, two were "general interest" sessions in charge of the officers of Section B and five were occupied with research papers, in charge of the American Physical Society. In all seventy-four papers were presented and one symposium held. Eight papers were presented by title only.

The presiding officers were Professor R. A. Millikan, vice-president of Section B, and Professor W. F. Magie, president of the Physical Society. At a short business session of the section Professor Theodore Lyman was elected to represent the section on the council, Professor C. E. Mendenhall a member of the sectional committee (for five years) and Professor F. A. Saunders a member of the general committee.

All sessions were held in a large laboratory of the Bureau of Standards. The attendance at several was about two hundred and for most others exceeded one hundred. It was probably the largest and most representative gathering of physicists

ever held in America. In each of the three days when two sessions were held the scientific staff of the bureau generously provided a fine lunch for all in attendance.

The address of the retiring president of the association was of special interest to physicists this year. It was given on Wednesday evening in the assembly hall of the new National Museum by Professor A. A. Michelson on the subject "Recent Progress in Spectroscopic Methods."

On Friday evening a subscription dinner was given by the Philosophical Society of Washington in honor of Section B and the American Physical Society at the Shoreham Hotel. This was attended by about one hundred and was a most delightful occasion. Dr. E. B. Rosa, the retiring vice-president, acted as toastmaster and Professor A. A. Michelson, the retiring president of the association, was among the guests of honor.

Among the members of the association who were elected fellows by action of the council at this meeting are the following members of Section B: H. A. Wilson, Frank Wenner, Fay C. Brown, E. A. Harrington and W. J. Fisher.

The officers for the next annual meeting, to be held in Cleveland during the convocation week of 1912-13, are as follows:

Vice-president and Chairman of Section B—Professor A. G. Webster, Clark University.

Retiring Vice-president—Professor Robert A. Millikan, University of Chicago.

Secretary—Dr. W. J. Humphreys, U. S. Weather Bureau, Washington.

Member of Council—Professor Theodore Lyman, Harvard University.

Sectional Committee—R. A. Millikan, A. G. Webster, W. J. Humphreys, A. P. Carman, G. F. Hull, E. L. Nichols, A. Zeleny, C. E. Mendenhall and the president and secretary of the American Physical Society.

The two general-interest sessions in charge of Section B were held on Thursday, December 28. At the morning session Professor W. F. Magie, of Princeton, delivered the presidential address of the American Physical Society on "The Primary Concepts of Physics." This is given in full in the February 23 issue of SCIENCE. The remainder of the morning session was devoted to a symposium on "The Ether," led by Professor A. A. Michelson. Professors A. G. Webster, E. W. Morley, W. S. Franklin, D. F. Comstock and G. N. Lewis took part in the discussion. The significance and place of the principle of relativity was of course given principal attention and some difficulty was

experienced in finding common ground upon which to stand. At the afternoon session of the same day the retiring chairman of Section B gave his vice-presidential address upon "The Work of the Electrical Division of the Bureau of Standards." This is printed in full in the January 5 number of SCIENCE. Then followed an address by Professor H. A. Wilson, on "The Structure of the Atom," and by Director S. W. Stratton, on "The Work of the Bureau of Standards."

The following are abstracts of these addresses:

The Structure of Atoms: Professor H. A. WILSON, McGill University.

The essential constituent of matter appears to be electricity; recent researches, experimental and theoretical, suggest that electricity is in fact the only constituent of matter.

Free negative electrons can be obtained from almost any form of matter by heating, by the action of ultra-violet light or in other ways. The optical properties of matter are now explained by the presence of negative electrons; the Zeeman effect and dispersion may be specially mentioned. Many of the electrical and thermal properties of metals have been satisfactorily explained by supposing that metals contain negative electrons which move about inside them like the molecules of a gas.

Negative electrons must therefore be regarded as a universal constituent of all forms of matter. These electrons, moreover, are with good reason believed to be simply minute particles of negative electricity of much less than atomic size.

Electrically neutral matter must contain as much positive electricity as negative; it is clear, therefore, that all matter must also contain positive electricity. One of the most important results of recent electrical researches is the fact that while free negative electrons can be easily obtained from any kind of matter, positive electricity is always associated with at least one atom and never appears in the form of positive electrons. Positively charged molecules seem to be in all cases the result of the removal of negative electrons from neutral molecules. Since it appears that all negative electricity is made up of equal particles and since it is very probable that any atom can be exactly neutral it follows that the amount of positive electricity in any atom must be an exact multiple of the charge of one negative electron. This makes it probable that positive electricity is also made up of equal parts, but so far they have not been obtained free.

The absence of effects due to the earth's motion

relative to the ether can be explained on the electromagnetic theory if it is supposed that this theory covers all phenomena. This appears to be a strong argument in favor of the purely electrical nature of matter.

It will be convenient now to mention the chief electrical theories of atomic structure which have been proposed.

According to Sir J. J. Thomson, atoms consist of solid spheres of positive electricity inside which negative electrons move about freely. If the sphere is taken to be of uniform density then a negative electron is attracted towards the center with a force proportional to its distance from the center. The electrons of course repel each other. The electrons will distribute themselves uniformly throughout the sphere so as to neutralize it as completely as possible and can vibrate about their positions of equilibrium. According to Sir J. Larmor, atoms consist of a number of positive and negative electrons describing orbits about each other. There may be rings of electrons revolving round concentric rings. On this view an atom is a sort of small gaseous nebula without any sort of solid foundation.

A third theory recently adopted by Rutherford regards the atom as containing a nucleus of positive electricity with negative electrons outside it; probably describing orbits around it. On this view the atom is a sort of minute solar system. The positive nucleus will always require the same number of negative electrons to keep it neutral so that it provides a definite foundation fixing the identity of the atom. The same may be said of the sphere in Sir J. J. Thomson's theory.

I shall now proceed to very briefly review some of the evidence as to the nature of atoms that can be derived from different branches of physics and to consider how far the theories mentioned are consistent with it.

The most important property of atoms is their extraordinary stability in presence of each other. For example, the atoms in a compound molecule are very intimately associated and yet they preserve their identity even at the highest temperatures. The molecules in a gas are continually colliding violently with other molecules, yet the atoms are not destroyed. Negative electrons can be knocked out of atoms by the impact of rapidly moving particles such as the cathode rays and α rays, yet the atoms retain their identity and after regaining negative electrons are unaffected. Facts like these appear to be decisive against Sir J. Larmor's theory. On this theory we should expect

all mixtures of different substances to rapidly change into the same substance. There is in fact nothing in Sir J. Larmor's theory to account for the stability of atoms which according to any such theory would be broken up by collisions and could not preserve their identity in compound molecules. This theory fails to explain why free positive electrons can not be obtained while negative electrons are easily isolated. On the other two theories the stability of the atoms can be ascribed to the stability of the positive sphere or nucleus. When negative electrons are knocked out of the atom the excess of positive charge can only be neutralized by an equal number being replaced, which restores the atom to its original condition. Important evidence as to the nature of atoms is provided by the properties of gases interpreted according to the kinetic theory. The viscosity, rate of diffusion and other properties of gases seem to be best explained if the molecules are regarded as having a definite volume of radius about 10^{-8} cm. This is usually termed the radius of molecular action and two molecules which are separated by a distance greater than about 10^{-8} cm. can be regarded as having no appreciable action on each other. Similar conclusions can be derived from the theory of surface tension and many other phenomena. The energy necessary to remove a negative electron from an atom, for example, indicates that the positive and negative charges are about 10^{-8} cm. apart in the atom.

The most important evidence from the kinetic theory is derived from the ratio of the specific heat at constant pressure to that at constant volume. This ratio γ is equal, according to the theory, to $1 + 2/n$ where n is the number of degrees of freedom per molecule. For helium, neon, argon, krypton, xenon, mercury vapor and other gases $\gamma = 1.66$, which requires that $n = 3$. This means that when such gases are heated all the energy goes into the three degrees of freedom of translational motion of the molecules, so that the molecules acquire no energy of rotation or vibration. To explain this it appears necessary to suppose that the molecules behave like rigid smooth spheres. Such gases are therefore believed to be monatomic, each atom behaving like a smooth sphere. These gases, however, give spectra containing many lines so that it is certain that their atoms contain electrons which can vibrate. It is necessary to suppose that collisions between these atoms do not set their electrons in vibration, which seems to require the electrons to be protected in some way. This seems to be strongly in favor of

Sir J. J. Thomson's theory and against the other two theories, for if the electrons were describing orbits outside it is hard to see how they could escape violent disturbance during a collision.

Gases like nitrogen, hydrogen and carbonmonoxide have $\gamma = 1.4$, which gives $n = 5$. This means that their molecules behave like smooth rigid solids of revolution. These gases are diatomic, so that it appears that the two atoms in the molecule are firmly fixed together. This can be explained on Sir J. J. Thomson's theory by supposing that the two positive spheres stick together and it can not be explained on the other two theories.

The theory of the constitution of chemical compounds seems to require the atoms in compound molecules to be firmly fixed together in definite relative positions. The numerous cases of stereoisomerism and optically active isomers seem conclusive as to this. Similar conclusions follow from the properties of crystals which can be explained in many cases by supposing the atoms combined in a definite way throughout the crystal so that the whole crystal is, so to speak, one large molecule.¹ The rigidity of many crystals requires the atoms to be firmly fixed together.

On Sir J. J. Thomson's theory two atoms can stick together if one or more electrons are transferred from one to the other. In this case they would attract each other with great force and we may suppose the positive spheres to be flattened up against each other by the pressure so as to form a rigid combination.

Sir J. Larmor's theory and Rutherford's planetary theory are difficult to reconcile with the idea that atoms become firmly fixed together in compounds and rigid solids. On such theories we should expect to have nothing but gases and liquids and only very simple compounds.

Another important property of solids is their impenetrability by gases. This seems to require the atoms to occupy nearly the whole volume. The compressibility of solids is not great and does not diminish much at low temperatures. If atoms were made up merely of electrons of very minute volume we should expect solids at very low temperatures to contract to a very small volume or at any rate to become easily compressible. This again is in favor of atoms with a definite volume of radius about 10^{-8} cm. as on Sir J. J. Thomson's theory. This argument is taken from the Faraday lecture for 1911 by Professor Richards, who puts

¹ See A. E. H. Tutton, "Crystallography," London, 1911.

forward many good reasons for the view that atoms have a definite volume and are compressible.

The number of negative electrons in atoms can be deduced from observations on the scattering of the β rays of radium or of Röntgen rays and in other ways, as Sir J. J. Thomson has shown. The results obtained indicate that the number is a small constant multiple of the atomic weight.

The scattering of α rays led Rutherford to adopt the idea of a positive nucleus, since some α rays are turned through a larger angle than can be explained by the electric forces due to a charge equal to that on one electron. It may be, however, that other forces besides ordinary electric force act on α rays when moving through matter. The α rays are helium atoms which have a radius about 10^{-8} cm., so that they probably only get through by displacing the atoms of the matter. If we suppose the positive sphere of one atom can not penetrate into that of another then the scattering of α rays by matter can probably be explained on Sir J. J. Thomson's theory.

The most interesting application of Sir J. J. Thomson's theory is the explanation which it affords of the relation between the atoms in series of similar elements like fluorine, chlorine, bromine, iodine. Sir J. J. Thomson supposes that the negative electrons in the sphere are arranged in concentric spherical layers and that each element in a series of similar elements is derived from the one before it by the addition of one more layer. The writer² has worked out this idea and shown that it is in approximate agreement with the atomic weights and that the number of electrons per atom can be deduced approximately from the atomic weights. The result obtained was that the number of electrons is about eight times the atomic weight.

Probably the most promising of the many ways of obtaining evidence as to the structure of atoms is by the study of the spectra of the light which they give out when set vibrating by different disturbing agencies. Most spectra, however, are so complicated that very little progress has yet been made. The fact that spectra contain lines of definite wave length suggests that the electrons in the atom vibrate about positions of equilibrium or else are moving in magnetic fields of constant strength. This seems to be a strong argument against theories of the planetary type, for on such theories the period of vibration is not fixed, but depends on the radius of the orbit.

Any theory which explains spectra ought also to explain the Zeemann effect.

² *Phil. Mag.*, June, 1911.

An important question is whether all the lines in the spectrum of an element can be emitted by each atom or whether the different lines are emitted by different systems. The second view now seems the more probable. On this view the different lines do not correspond to the different possible modes of vibration of each atom, but each line is due to the vibration of a different system. Of course a particular system may give more than one line in some cases. Thus we might suppose a regular series of n lines to be due to the vibrations of molecules with one, two, three up to n atoms in the molecule. Other series for the same element might be due to molecules which had each lost say m electrons with up to n atoms per molecule. On this view the frequency of vibration would be a function of two integers n and m . The different series in the spectra of the alkalis can be represented approximately as functions of two integers, as is well known.

The only theories of series spectra which have been developed to any extent are due to Ritz ("Gesammelte Werke W. Ritz," Paris, 1911). In his earlier papers he supposed the lines in each series to be due to different modes of vibration of an elastic membrane having special properties. Later he abandoned this view and supposed each line due to a different system.

Ritz's atomic vibrator consists of an electron vibrating in the magnetic field of a bar magnet at a point along its axis. The electron is supposed to stay close to a particular point on the axis and to vibrate in the plane perpendicular to the axis. The distance from the electron to the nearest pole is taken to vary by equal increments and the distance between the two poles also is supposed to vary by equal increments in going from one atom to another. This makes the frequency a function of two integers and the function found agrees approximately with the observed frequencies. However, to obtain exact agreement Ritz had to suppose the increments to be not always exactly equal. Ritz supposed the bar magnet to be made up of a row of nearly equal elementary magnets. In any atom some of the elementary magnets are in the row and the rest may be supposed arranged so as to neutralize each other.

This idea of elementary magnets receives some support from recent work on the magnetic properties of bodies by Weiss and others. The elementary magnets of course may consist of electrons moving round orbits.

It now seems probable that the formulæ proposed for the representation of series spectra are not quite exact and are consequently to be regarded as merely empirical and so without much real physical significance. Almost any function of integers containing four or five arbitrary constants will represent with accuracy a series of values which vary in a regular way.

Ritz's theory seems to the writer to be very artificial and altogether improbable.

In conclusion we may say that while we are still far from arriving at a complete theory of atomic structure yet some progress has been made in that direction. It is easy to get a theory which will explain any particular set of facts, but the same theory will not explain all the different sets of facts.

As to the bearing of radioactivity on this question reference may be made to a paper by J. W. Nicholson in the *Philosophical Magazine* for December, 1911. The serious objections to planetary theories pointed out above apply to his suggestions. *The Work of the Bureau of Standards*: Dr. S. W. STRATTON, Director.

For purposes of administration, the Bureau of Standards is for the present divided into seven divisions. The first four are based somewhat upon the usual divisions of the subject of physics, the work consisting primarily in the solution of problems relating to standards of measurement, precision measuring instruments, methods of measurement and the determination of constants. They also investigate the properties of materials when the determination of such properties involves the services and equipment of the physicist rather than those of the engineer. The fifth division includes the principal chemical work of the bureau. The sixth division, having to do principally with engineering tests and investigations not ordinarily included in the four physical divisions, is scarcely organized as yet, except in certain lines of testing. The seventh division, the newest and largest in the bureau, relates to the investigation and testing of engineering, structural and miscellaneous materials. The various divisions are subdivided into sections, based upon the natural classification of their work, and sometimes upon the lines along which the experts specialize. The bureau is perhaps unique in bringing together the physicist, the chemist and the engineering investigator into closer relationship than at any other scientific institution in the country. Every effort is made to promote cooperation, even at the expense of organization if need be.

The act establishing the Bureau of Standards authorizes it to take up, in addition to the usual problems in connection with the physical units and standards, the determination of physical constants and the properties of materials, that is to say, Congress in enacting this law recognized the necessity for standard values of constants and standards of quality as well as standards of measurement. Uniform and accurate values of physical constants are as essential in scientific investigation, engineering work or commerce and trade as are uniform and reliable standards of length or mass. Similarly, well determined and defined properties of materials are equally important in the design of structures, the operation of machinery and the various mechanical uses of materials. A knowledge of materials is necessary for their most efficient and economical use. The problems awaiting solution in connection with the properties of materials are almost infinite in number; hence, the bureau's work in this direction will be confined for some time to come to those investigations which are necessary for the production of standard values or authoritative data.

Attention should be directed to certain phases of the bureau's work, which are of great importance and which might be called the "by-products" of the bureau. These are, furnishing to the public information acquired by the bureau in the exercise of its functions; the giving of information to the other bureaus and institutions of the government concerning physical, chemical and engineering questions involved in their work, and the giving of information to state and municipal governments and especially to public service commissions, which are becoming a very important factor in state legislation. The experts of the bureau are consulted in regard to scientific principles involved in the enactment of legislation and the establishment of regulations. At this time the bureau has in press several publications intended primarily for the assistance of state and municipal governments and public service commissions. Another important "by-product" is the influence that the bureau is exerting upon the development of scientific methods and the establishment of research laboratories in connection with our industries. The efforts of the bureau in connection with the work of these laboratories and in undertaking its own technical researches will always be directed toward basing such investigations on sound scientific principles, and to assist those industries in a wider and more efficient use of the scientific discoveries. Finally, through the efforts

and influence of the bureau it has been largely instrumental in bringing into closer cooperation the different national bureaus with a view to international agreement as to the fundamental questions involved in matters pertaining to standards.

The following seventy research papers were presented at the sessions of Wednesday, Friday and Saturday, in charge of the officers of the American Physical Society. Most of them will be published, either in abstract or in full, in the *Physical Review*.

"An Important Practical Problem in Gyrostatic Action," W. S. Franklin, Lehigh University.

"A Relation between the Magnetic Hysteresis and the Tensile Strength of a Series of Iron-carbon Alloys," C. W. Waggoner, West Virginia University. (Read by title.)

"Relation between the Joule Effect and the Permeability in the Same Specimens of Steel," S. R. Williams, Oberlin College.

"A Magnetic Test as a Means of Determining Flaws and Mechanical Strains in Iron and Steel," Chas. W. Burrows, Bureau of Standards.

"The Electrical Resistance and the Polarization E.M.F. of a Mixture of Clay, Feldspar and Quartz," A. A. Somerville and O. E. Buckley, Cornell University.

"A Kinetic Theory of Gravitation; Some Explanatory Remarks on my Paper of Last Year," Charles F. Brush, Cleveland.

"Some Diffraction Photographs," Mason E. Hufford, Indiana University.

"Demonstration of Linear and Surface Thermopiles of Bismuth and Silver," W. W. Coblentz, Bureau of Standards.

"The Vertical Temperature Gradient of the Atmosphere," Wm. R. Blair, Mount Weather Observatory, Bluemont, Va.

"A Modified View of Electronic Conduction," Walter P. White, Geophysical Laboratory.

"The Application of Statistical Principles to Photoelectric Effects and Some Allied Phenomena," O. W. Richardson, Princeton University. (By title.)

"The Velocity-distribution Curves of Electrons Liberated by Different Sources of Ultra-violet Light, and the Bearing of these Curves on the Planck-Einstein Theory," R. A. Millikan, University of Chicago.

"A Study of Crystal Rectifiers," R. H. Goddard, Clark University.

"The Half-value of the Radioactive Deposit Col-

lected in the Open Air," F. A. Harvey, Syracuse University.

"Distribution of Current in Point-Plane Discharge," Robt. F. Earhart, Ohio State University.

"The Influence of Temperature on the Phenomena of Phosphorescence in Zinc Sulphide," H. E. Ives and M. Luckiesh.

"On the Free Vibrations of a Lecher System using a Lecher Oscillator, II," F. C. Blake, Ohio State University. (Read by title.)

"The Thomson Effect in, and the Thermal Conductivity of Tungsten, Tantalum and Carbon at Glowing Temperatures," A. G. Worthing, National Electric Lamp Association, Cleveland.

"The Effect of the Electrical Discharge on Solids and Liquids Suspended in Air," W. W. Strong, University of Pittsburgh.

"A Quantitative Measure of Development in Scientific Observation," Otto Stuhlmann, Jr., Stevens Institute of Technology, Hoboken, N. J.

"Elastic Hysteresis in Metal Bars," A. G. Webster and T. L. Porter, Clark University.

"The Spectra of Iron and Titanium at Moderate Pressure," H. G. Gale, Chicago University.

"The Spark Spectra of the Alkaline Earths in the Schumann Region," Theodore Lyman, Jefferson Physical Laboratory, Harvard University.

"Demonstration of the Resonance Spectrum of Iodine in Vacuo and in Helium," R. W. Wood, Johns Hopkins University.

"A Convenient Device for Obtaining a Steady High Potential for Electrometer Work," A. H. Forman, Cornell University. Introduced by J. S. Shearer.

"The Form of CO_2 , SO_2 and NH_3 Crystals," H. E. Behnken. (Introduced by J. S. Shearer.)

"A New Method of Photographing Sound Waves," A. L. Foley and W. H. Souder, Indiana University.

"Another Instrument for Photographing Sound," A. G. Webster, Clark University.

"The Influence of the Natural Periods of Concentrating Horn and Diaphragm upon Sound Wave Records, and the Quantitative Analyses of Tones from Several Musical Instruments," D. C. Miller, Case School of Applied Sciences.

"Slit Width Corrections in the Photometry of Black Body Spectra," E. P. Hyde, National Electric Lamp Association, Cleveland.

"The Effect of Temperature on the Absorbed Charge in Electric Condensers," Anthony Zeleny, University of Minnesota.

"The Influence of Neighboring Conductors upon

a Klemencic Receiver of Electric Waves," A. D. Cole, Ohio State University.

"The Absorption of Beta Rays by Gases," A. F. Kovarik, University of Minnesota. (Read by title.)

"The Absorption of Gamma Rays of Radium by Air at Different Pressures," H. A. Erikson, University of Minnesota.

"Poynting's Tangential Method for showing the Existence of Radiation Pressure an Assumption unwarranted by Experiment," R. A. Wetzel, College of the City of New York.

"A New Type of Curve Drawing Instrument and Controllor Mechanism," M. E. Leeds, Philadelphia, Pa.

"The Silver Voltameter as a Precision Instrument," E. B. Rosa, Bureau of Standards.

"Recent Work with the Silver Voltameter," G. W. Vinal, Bureau of Standards.

"The Dielectric Constant, Specific Resistance and Electrostatic Absorption of Crystals," H. L. Curtis, Bureau of Standards.

"A New Type of Apparatus for Measuring Linear Expansion," Arthur W. Gray, Bureau of Standards.

"Temperature Influence upon the Refraction of Quartz, Boro-silicate Crown Glass, and Dense Flint Glass, from 100° C. to -190° C.," F. A. Molby, Cornell University.

"Thermo E.M.F. of the Nerst Filament," J. S. Shearer, Cornell University.

"Diffraction Gratings with Controlled Groove and Anomalous Distribution of Intensity" (illustrated with experiments), R. W. Wood, Johns Hopkins University.

"Further Investigations with the Radiant Emission from the Electric Spark," R. W. Wood, Johns Hopkins University.

"A New Type of Neutral Double Potentiometer," Walter P. White, Geophysical Laboratory.

"Note on the Ascensional Rate of the Free Balloons used for Meteorological Purposes," Wm. R. Blair, Mount Weather Observatory, Bluemont, Va.

"A Modified View of the Electron Theory of Thermoelectricity," Walter P. White, Geophysical Laboratory.

"A Simple Dynamical Example of the Genesis of an Integral Equation," A. G. Webster, Clark University.

"A New Way to Determine g ," A. G. Webster, Clark University.

"On the Effect of Close Electrostatic Coupling

on the Free Period of a Lecher System," F. C. Blake, Ohio State University. (Read by title.)

"Poynting's Theorem and the Equation of Electromagnetic Action," W. S. Franklin, Lehigh University.

"A Simple Slit for the Spectroscope," J. P. Naylor, DePauw University.

"The Applicability of the Planck Equation to the Radiation from Tantalum and Tungsten," E. P. Hyde, National Electric Lamp Association, Cleveland.

"Evidence that the Velocity of Light is Independent of the Motion of the Source," D. F. Comstock, Massachusetts Institute of Technology.

"The Specific Heat of Wood," Frederick Dunlap, Department of Agriculture, Washington.

"On the Relation between Pressure Displacement and Wave-length," W. S. Adams and H. G. Gale, University of Chicago.

"The Expansion of Water below 0° C.," J. F. Mohler, Dickinson College.

"The Transmission of the Active Deposit of Radium in an Electric Field," E. M. Wellisch, Yale University.

"A New Form of Vacuum Pump," J. Johnston, Geophysical Laboratory.

"The Emission of Light by Hydrogen Canal Rays," G. S. Fulcher, University of Wisconsin.

"A Sensitive Vacuum Thermal Couple and Method for Producing High Vacua," A. H. Pfund, Johns Hopkins University.

"On Magnetic Rays," L. T. More and E. G. Rieman, University of Cincinnati. (Read by title.)

"The Wave-Lengths of Neon," I. G. Priest, Bureau of Standards.

"The Electric Discharge from Pointed Conductors," John Zeleny, University of Minnesota.

"Ellipticity and Rotation in Optically Active Solutions," L. B. Olmstead, Bureau of Standards.

"The Language of Meteorology," C. F. Talman, Washington.

"The Joule Thomson Effect in CO₂," E. S. Burnett, Cornell University.

"On the Theory of the Hysteresis Loop of Iron," J. Kunz, University of Illinois.

"The Photo-electric Effect in Phosphorescent Materials," G. A. Butman, Yale University.

"An Absolute Determination of the Coefficient of Viscosity of Air," L. Gilchrist, Univ. of Toronto.

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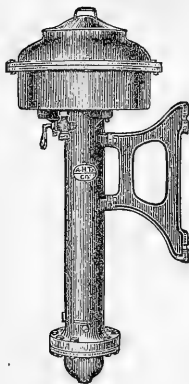
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THE PROCEEDINGS AT THE CENTENARY OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

AN adequate celebration of the one hundredth anniversary of the academy was urged by the academy secretary early in February, 1911, and was entrusted to a general committee of forty-three. The celebration thus provided for extended over three days: the 19th, 20th and 21st of March. It began on the 19th because that was the stated meeting night of the academy, the 21st being the actual date of the anniversary. The lecture hall on the evening of the 19th was well filled with people, the front seats being occupied by delegates, who, to the number of one hundred and forty-seven, had been appointed by corresponding societies at home and abroad.

The president of the academy, the Honorable Samuel Gibson Dixon, M.D., LL.D., took the chair promptly at 8 P.M., and introduced the Honorable Rudolph Blankenburg, mayor of Philadelphia, who, in a few well-chosen words, cordially welcomed the visiting scientists to the city. The recording secretary, Edward J. Nolan, M.D., then requested the delegates, as the names of the societies they represented were called by the corresponding secretary, J. Percy Moore, Ph.D., to arise, bow, and hand their letters of credential and congratulation to the president without reading. As the exercises of the evening were likely to be lengthy, he asked that any remarks considered desirable should be very brief. Thus warned, as a matter of fact, no one spoke, and as much the greater number of the two hundred and eighty-six letters received from all parts of the world

had been already delivered by mail, this otherwise tedious part of the program was not unduly prolonged.

The president then delivered his historical address as follows:

ADDRESS OF THE PRESIDENT

Fellow Members and Guests: This is one of the occasions which stimulate reflection. To-day we must all feel a regret that we can not inherit the learning of those who have gone before us. So keen an appreciation do I possess of the unselfish devotion of my predecessors to science and to this institution, and so impressed am I at our monthly meetings in our reading room by the regard of their portraits hanging on our walls, that I am impelled to call upon them in spirit to join me in extending to our guests the heartiest of welcome and to say that we, the present workers, fully appreciate how much credit is due them for our present success.

To-day this City of Brotherly Love, with the mother commonwealth, Pennsylvania, in common with the great union of states, is in peace with all the nations of the globe. This blessed condition did not prevail on the day when our forefathers assembled one hundred years ago, to organize an institution for the study and advancement of the natural sciences. During the last days of the year 1811, the dispute between the United States and Great Britain and the doubt as to the attitude of France seemed to indicate that the national honor was hurt and that another contest with a European power was at hand. The commerce of the country had suffered. The Committee on Foreign Relations recited the wrongs that the United States had suffered from Great Britain, and declared it to be the sacred duty of Congress to call forth the patriotism and resources of the country. Extensive military measures were

recommended. The Pennsylvania Legislature passed acts for enlarging the regiment of artillery and for the organization of the cavalry of the city of Philadelphia. Although war was not declared until June, 1812, in anticipation of the necessities of the situation Congress approved a loan of eleven million dollars, of which one million six hundred and forty-five thousand dollars was raised in Philadelphia.

Large meetings of people took place all over the city to consider the needs of commercial interests and to pass resolutions for the equipment of privateers and for building up the defenses of the city.

The legislature relieved the tension of its patriotic resolutions by requesting a special committee to examine a machine made by Charles Redheffer, who claimed that it possessed the power of self motion, and naïvely stated that "if the machine be found to be imperfect the public interest will be promoted by exposing its fallacy."

In the midst of these excitements the youth of the city naturally sought the taverns and oyster cellars as meeting places, as indeed there was little in the way of diversion provided for the people of that period. The theater was seldom opened, and the feeling against it was so strong that a petition was presented to the legislature requesting it to abolish forever the exhibition of "Theatricals." Peale's Museum enjoyed great popularity, and here the *lusus naturæ* was in steady demand. The calf with five legs vied for public favor with the child without ears.

Notwithstanding the preparations for war which were draining the resources of all men, the fathers of this institution had such faith in the future of the United States of America that they did not hesitate, even with the din of martial demonstrations in their ears and the consciousness of an awful, impending struggle with

gigantic powers in their minds, to proceed quietly, methodically and unperturbed to found an association for pure learning which has now become one of the foremost among the scientific institutions of the world.

The vibrations, whose echoes still resound in this Hall of Science, though the voices that started them can no longer be heard, are too numerous to be mentioned on this occasion, when there is so much that is new to be brought out within the short time allotted for our assemblage for the last time in the academy's first century.

This institution was born of the enthusiasm of earnest lovers of science. They had before them a single purpose, the unveiling of the laws of nature and the engraving of them on the tablets of the society that they might be studied by men of all nations. To accomplish this great end as the society grew they realized the necessity of exploration, of collections, of laboratories, of a library and of reciprocity with bodies having similar aims.

In the beginning of the nineteenth century a few young men in this city spent their spare time in studying natural history. They soon learned it was to their mutual interest to meet to compare notes. In the year 1812 John Speakman and Jacob Gilliams agreed that it would be well to hold regular meetings; accordingly, they, with Drs. Gerard Troost, Jr., Nicholas S. Parmentier, Camillus Macmahon Mann and John Shinn, Jr., met at the home of one of their members on the northwest corner of Market and 2d Streets, on January 25, 1812. The minutes of this meeting set forth that their meetings would be for the rational disposition of their leisure moments. Their next meeting was held at a public house on Market Street near Franklin Place on the 21st day of March, 1812, at which time Dr. Samuel Jackson,

of the University of Pennsylvania, suggested the title of The Academy of Natural Sciences. The collection of the society at this time was represented by a few common insects, a few corals and shells, a dried toad fish and a stuffed monkey.

Thus established, the academy, with its constantly increasing resources, has been for one hundred years free for the use of all students of natural history.

The masters of science have come from all parts of the world to consult the great zoological, botanical, geological and ethnological collections which the accumulated labors of our members, during a century of activity, have brought together in our museum.

Writers and students of all grades have come to consult the wonderful natural-history library which the liberality of our members and the world-wide exchange of our own publications have enabled us to gather on our shelves.

Pupils from our schools have come under the guidance of their teachers to study and profit by the exhibits displayed in our public museum halls, while our specialists have delivered courses of popular lectures on the natural sciences under the auspices of the academy and the Ludwick Institute.

In every way within its power the academy has stood for a century as the advocate of the study of the natural sciences, advanced or elementary, pure or applied.

And this, our one hundredth anniversary, is a particularly happy birthday because our precious natural history library of volumes unexcelled in America, and our priceless collections of mammals, birds, reptiles, fishes, shells, insects, plants, ethnological and geological specimens unsurpassed in several of the departments and all of them rich in the type specimens of the early naturalists of America, having been for almost one hundred years exposed

to the danger of damage or destruction from fire, are now, through the intelligent liberality of the commonwealth of Pennsylvania, placed in a thoroughly fire-proof building.

The society has, however, never received state or city financial aid for maintenance, but has depended entirely upon the liberality of intelligent people, mainly of Philadelphia, to contribute the necessary funds to purchase land for our buildings, to publish the results of the scientific researches of our members, to fit out expeditions and of late years to pay meager salaries to the members of our scientific staff.

While we have thus built up fine study collections, it has been impossible to develop the popular exhibits that other sister institutions, rich in state and municipal appropriations, have been enabled to instal.

We have, however, kept our collections systematically arranged and have, during the last decade, had the satisfaction of seeing all our historical types and the numerous recent accessions placed in metal cases, impervious to light, dust or moth; which will insure them the longest possible life.

Our honorary corresponding membership now numbers about two hundred, composed of the greatest scientists of the period.

Biographical sketches of our officers and scientific workers who carried us through the last one hundred years are printed in our publications, and as we have so little time before us they can only be casually alluded to in this brief résumé of the academy's history. We are, however, proud of the escutcheon upon which the history of their lives is engraved.

Members of this academy have taken a very prominent part in explorations. Thomas Say was a member of the "Long Expedition" to the Rocky Mountains in 1819 and 1820 and was one of the first scientific men to become personally ac-

quainted with the vast natural history resources of the great west.

Nuttall and Townsend, thirty years after the Lewis and Clark expedition, crossed the continent to the mouth of the Columbia River, and then extended their explorations to the Hawaiian Islands, returning around the Horn. They brought home rarities of animal and plant life, many of which were unknown to science. These collections were placed in the academy's museum, then the chief repository for natural-history specimens in America and here they are still preserved.

When the United States government was organizing the famous Wilkes expedition of 1838, the academy was requested to nominate its scientific staff and two of its members eventually accompanied the party.

In the year 1850 one of our members, Edward Harris, financed and accompanied the great Audubon expedition up the Missouri River. Through his modesty, we were prevented at the time from making known the important part that he took in this expedition. Other members made possible the exploration of DuChaillu in equatorial Africa.

We provided Dr. Kane with his outfit for systematic collecting in 1853 when he made his Arctic expedition. To-day we have in our collection his famous Esquimau dog, "Toodla," as well as numerous other specimens obtained by him. Specially interesting is the gigantic stuffed polar bear which stands in interesting contrast to the modern mounted specimen brought here by the Peary "relief expedition."

The Hayes expedition to the far north a few years later was also aided and endorsed by the academy.

Rear Admiral Peary, discouraged by his futile attempts to interest other institutions and governments in his proposed voyage of exploration to the north, came to us

with his proposition. He was generously received and a committee was appointed to arrange the expedition, which sailed on June 6, 1891, from Brooklyn, under the auspices of the academy, to explore the Arctic regions. On January 26, 1892, we authorized a relief expedition under the command of Professor Heilprin. On September 24, 1892, we officially met the relief expedition sailing up the Delaware River on the now historic vessel *Kite*.

Dr. Hayden, a member of the academy, when conducting the United States Geological Survey in the west, made up his scientific parties largely from our membership. The setting apart of the great national Yellowstone Park resulted from his numerous explorations. Every three years this institution bestows upon a distinguished geologist a gold medal called the Hayden Medal, an award which was founded by Dr. Hayden's widow.

The Pennsylvania Geological Surveys were also conducted by our academy members, Rogers and Lesley.

Our famous colleagues, Leidy and Cope, were the pioneers in describing the extinct animals from the wonderful deposits of the western states.

I may mention among the more recent expeditions the one under Professor Heilprin to Yucatan and Mexico in 1890, the Harrison and Hiller expedition to Sumatra, the numerous explorations of Mr. Clarence B. Moore, the Rhoads expeditions to British Columbia, Colorado and Ecuador, the Donaldson-Smith expedition to Somaliland and Lake Rudolph, and the Bond expedition to Venezuela, from all of which we have received rich returns.

The academy publications had early a world-wide reputation. For many years they furnished the only adequate means through which American scientists reached the naturalists of the world. Contributions

for publication came from all parts of America. To-day our *Proceedings* and *Journal* are exchanged with all the nations of the civilized world. It may be interesting to state here the fact that when the famous Pacific railroad surveys were made the United States government published descriptions of all the new specimens it obtained in the academy *Proceedings*.

Passing rapidly over the more important departments of our museum, we find among mammals a number of the specimens obtained by Townsend in the far west, made known to science in our *Journal* by our correspondents Audubon and Bachman; the Harrison Allen collection of bats, the Rhoads collection of North American mammals and the splendid collection of anthropoid apes presented by Dr. Thomas Biddle. Our collection of birds will ever stand as a memorial to two of our members, Thomas B. Wilson and John Cassin. To Dr. Wilson's liberality we owe the acquirement of the famous Rivoli collection, the Gould collection and many others. His entire gift, comprising some 25,000 specimens, was regarded in 1850 as the finest collection in the world. Cassin spent his life in the study of this vast collection and his researches published in our *Proceedings* made our academy famous as an ornithological center, while he himself stood preeminent among the ornithologists of America.

The part that the academy played in the development of ornithology in America may be appreciated by the mere mention of those who worked within its walls or published the results of their researches in the *Proceedings*—Nuttall, Bonaparte, Townsend, Gambel, Heermann, Harris and Woodhouse, among our members, and Baird, Lawrence, Henry and Coues, among our correspondents.

In our vast series of reptiles, we find the material collected and studied by Hallowell,

Cope and Brown—names inseparable from the history of herpetology in America.

In the study of fishes at the academy the names of Bonaparte and Cope, already mentioned in other connections, stand forth prominently and their collections are still carefully preserved. Charles Lesueur, one of our earliest members, also attained fame as an ichthyologist, while of late years several of those who studied at the academy have become famous in the service of the United States Fish Commission—notably John Adam Ryder.

As regards mollusks, the academy has from its foundation taken a prominent part and has accumulated a collection probably second to none. A series of investigators, eminent in their special field, have made the society one of the world centers in the study of mollusks.

Almost a century ago Thomas Say blazed the trail for conchologists, while Dr. Isaac Lea and T. A. Conrad were his successors in the academy in this department. Lea's work, largely published by the academy, is the basis of all later systematic study of fresh-water mussels, while to Conrad we owe the foundation of American tertiary geology and paleontology, his work in this line overshadowing that on the living mollusca. Gabb was another famous worker in the same field, while to Geo. W. Tryon we owe the conception of the "Manual of Conchology," begun by him in 1878 and continued by the academy after his death in 1888. Very few works have led to so many reforms in classification or have such a broad influence as this. Dr. Joseph Leidy, who may be termed the Cuvier of America, should be mentioned in this connection because of his work forming the first volume of Binney's "Terrestrial Mollusks of the United States," published in 1851. This was the first American work on the morphology of the soft parts of our mollusks.

Thomas Say, already referred to as a pioneer conchologist, is also known as the father of American entomology. Owing to his energy, the academy's collection in this department was begun—a collection which by steady growth has reached a total of a million specimens and has become of world-wide renown. The long list of entomologists who have contributed to its development contains most of those whose activities constitute the earlier history of entomology in America.

Titian R. Peale, Wilson, LeConte, Horn, McCook, Cresson, Martindale and others have made our entomological department one of the first importance. The Cresson collection of hymenoptera has made the academy the greatest in America in this particular branch. The Bassett collection of galls and gall insects is the most comprehensive ever brought together.

In paleontology the names of Leidy and Cope are preeminent. The "Extinct Fauna of Dakota and Nebraska," published by Dr. Leidy in our *Journal*, is a classic. Students of paleontology still come to consult the types of his descriptions, most of which are preserved in our collection.

Professor Cope's part in the development of American paleontology is too well known to require detailed mention and was carried on side by side with his studies of reptiles and fishes, in which his reputation was equally great. On his death-bed he placed the finishing touches to his report on the pleistocene remains discovered at Port Kennedy, Pennsylvania, a paper which attracted the attention of the paleontological world and which appeared in the *Journal* of the academy soon after his death.

In botanical research the academy has always held an important place and its herbarium, now numbering some 900,000

specimens, contains the types of such pioneers as Nuttall, Pursh, Muhlenberg and de Schweinitz besides comprehensive collections from all parts of the globe. Among those whose researches have been carried on at the academy may be mentioned, in addition to the above, Durand, Charles E. Smith, Meehan and Redfield.

In anthropology the work of Morton and later of Harrison Allen is famous. The splendid collection of human crania brought together by the former is historic. Archeological and ethnological collections comprise the material gathered by S. S. Haldeman in North America and the land of the Aztecs, Mayas and Incas.

We have also the Wm. S. Vaux collection, rich in specimens of the neolithic age of Europe, the Robert H. Lamborn collection and the Clarence B. Moore collection.

This latter represents the results of more than twenty years' exploration in the southern United States and consists of thousands of specimens of the vanished art-industries of our southern aborigines now saved for all time in our museum and in the fine series of reports published in our *Journal*.

We have extensive mineral collections, foremost among which is the Wm. S. Vaux collection, famous for the beauty of its specimens and the completeness of the series.

There are the famous Febiger collection of diatoms and others, which lack of time forces me to pass over.

So, too, there are many former members of our academy who by their scientific attainments or their loyal and generous support have helped to build up the institution, while among our living members are men who are, by their work and devotion, fully as deserving of notice as those who have gone before.

Helmholtz, in 1862, said:

In fact men of science form, as it were, an organized army, laboring on behalf of the whole nation, and generally under its direction and at its expense, to augment the stock of such knowledge as may serve to promote industrial enterprise, to increase wealth, to adorn life, to improve political and social relations and to further the moral development of individual citizens. After the immediate practical results of their work we forbear to inquire; that we leave to the uninstructed. We are convinced that whatever contributes to the knowledge of the forces of nature or the powers of the human mind is worth cherishing, and may, in its own due time, bear practical fruits, very often where we should least have expected it.

It has been truly said that the distinctive feature of pure science is "that it is not remunerative; the practical rewards and returns are not the immediate ends in view." The work of Tyndall and Pasteur, however, on fermentation, pursued in the beginning purely because of its abstract scientific interest, later came to have enormous economic importance and led to the scientific investigations that have within recent years become of incalculable value to mankind.

The knowledge gathered by the abstract naturalist and the tabulation of scientific data concerning all forms of animal and vegetable life have a very close and direct relation to public health and preventive medicine. A long list of diseases might be compiled in which some of the insects are directly responsible for the transmission of the bacterium or parasite life causing disease. It is now a matter of almost universal knowledge that malarial fever is transmitted from man to man by means of the *Anopheles* mosquito, that the yellow fever virus can only be transmitted by the *Stegomyia calopus*, that the bubonic plague may be transmitted from man to man or from rat to man by means of the rat flea (*Pulex cheopis*), that the *Trypanosoma gambiense* of African sleeping sickness can be transmitted only by means of the tsetse-

fly, that the organism causing human filariasis is transmitted by the *Culex fatigans* and certain of the *Anopheles*, and evidence is gradually accumulating that the germ of leprosy is transmitted by the bed-bug (*Cimex lectularius*). A knowledge of the natural history of these insects is absolutely essential for the scientific study of the diseases with which they are so closely associated, and public health work has only been effective in eradicating these diseases in proportion to the efforts of the sanitarian directed toward their destruction or toward protecting individuals from them. The entomologist, the zoologist and the bacteriologist are each required to contribute their share in the research that means so much to public health and to mankind. If much has already been accomplished, still greater are the fields open for scientific investigation.

With the lower forms of animal life parasitic to man and known to cause disease, the connecting link, the intermediate host, the full life history is missing in many instances where it would seem that the most fertile field for the scientist has not yet been invaded. A very large field lies open for those who will undertake a careful study of the relation between the vermes and the human being. Much indeed has been learned about parasites inhabiting the intestinal canal, but the parasitologist has not yet concluded the final analysis of the life history of many of these parasites.

The work of the academy has been so distinctly pure science that the lay public have not until recently appreciated the great practical relationship it has to health and economics. The description of the various species, their life history, their geographical range, have enabled those working in applied sciences to conduct the already successful war against the enemies

to man, to the lower animals and to plant life.

Economic entomology, based upon abstract work, shows an annual money loss occasioned by insects as follows:

Cereals	\$300,000,000
Hay and forage	66,500,000
Cotton	85,000,000
Tobacco	10,000,000
Truck crops	150,000,000
Sugars	9,500,000
Fruits	30,000,000
Farm forests	11,000,000
Miscellaneous crops	10,000,000
Animal products	300,000,000
Natural forests and forest products ..	100,000,000
Products in storage	200,000,000
Total	\$1,272,000,000

Let it be remembered that in 1793 half the population of Philadelphia either died from yellow fever or voluntarily exiled themselves to escape from the scourge, that all the southern tier of states were kept in a state of constant terror every summer for fear of its invasion, causing a loss of millions to the commerce of the country, and then recall the fact that through entomological and medical cooperation this disease was practically eliminated from Cuba, its breeding place for ages, and that in 1905 a violent epidemic of the same plague was actually checked in New Orleans by the practical application of the knowledge gleaned by the medical department of our army in Cuba.

That mysterious blight to human life and energy, known as malaria, to which, as much as to the fire and sword of northern barbarians Greece and Rome owed their downfall, has been traced to its entomological source so that these two devastating diseases have ceased to be a menace to civilized communities, allowing that great work, the construction of the Panama Canal, heretofore impossible owing to their prevalence, to go on uninterruptedly under

conditions of unparalleled health, that the sacrifice of 5,000 American troops during the Spanish-American war was finally found to have been due to the transmission of bacillus typhosus by the common house fly, and that this knowledge was so judiciously applied by our army surgeons that a recent considerable mobilization of our soldiers was entirely exempt from that disease, and some faint conception will be reached of the immense debt that humanity owes to the patient workers in the field of pure science.

President George Washington, in his first message to Congress, said:

Nor am I less persuaded that you will agree with me in the opinion that there is nothing more deserving your patronage than the promotion of science and laboratories, knowing in every country it is the surest basis of public happiness, one in which the measures of the government receive their impressions so immediately from the sense of the community as ours it is proportionately essential.

The mass of congratulatory letters with their autographs of our foreign co-workers received from the great institutions of the world relating to this our one hundredth birthday, can not be read, owing to a lack of time.

Before closing I have a pleasant duty to perform in behalf of the Building Committee. At the request of those entrusted with planning and erecting the building improvements, made possible by the commonwealth of Pennsylvania, as chairman of said committee, I hand over to the corporate body, under the title of The Academy of Natural Sciences of Philadelphia, this building completed for its use, which comprises fire-proof stacks for its library, a reading room, lecture hall and work room. In the rhythmic language of another, I reverently invoke the blessings of the God of Nature upon this temple of the natural sciences.

Great God of nature, let these halls
The hidden things of earth make plain;
Let knowledge trumpet forth her calls,
And wisdom speak, but not in vain.

Help us to read with humble mind,
Thy larger scriptures day by day—
True bread of life! O be thou kind,
If, erring, we should go astray.

For deep resounding unto deep,
Declares the wonders of thy plan;
Life struggling from its crystal sleep
Finds glorious goal at last in man.

The mysteries of the eternal laws,
Are but the shadows of thy might.
God, ruling all in final cause,
Enshrines the world in love and light!

—Harvey Watts

At the conclusion of the address it was explained that the routine of a stated meeting would then go on, in the belief that an illustration of the formula by means of which the academy had transacted its business for one hundred years would be of interest to those familiar with the results which made it worth while to hold the celebration on which they were entering.

At the call of the chair the recording secretary read the minutes of the last meeting, and also the minute of the first recording secretary, Dr. Camillus Macmahon Mann, an exiled Irishman, defining the date of the foundation of the society. The latter is as follows:

Year of the United States the 37th,
March 21st.

In committee agreed: The year of the Institution shall commence at the present natural evolution: the spring equinox, 21st of March and the year shall be named according to the era of the United States of America in the principle city of which we assemble.

Additions to the museum and library were announced.

The corresponding secretary reported on the letters received.

The report of the council, confined almost entirely to a consideration of the ar-

rangements for the celebration, was read.

The publication committee reported the titles of papers presented for publication since the last meeting, and also announced the details of works to be issued in connection with the centenary celebration: a quarto volume of memoirs, an index to the entire series of the *Proceedings and Journal*, and a detailed history of the academy by the recording secretary, which will make a volume of not less than 400 pages and to which the "Short History" contributed to the Philadelphia Founders' Week Memorial Volume may be regarded as a prodomus.

The chair reported the death that morning of Thomas Harrison Montgomery, Ph.D., the director of the zoological department of the University of Pennsylvania. The occurrence supplied a pathetic note to the proceedings, as Dr. Montgomery had been deeply interested in the arrangements for the celebration, had been assigned a place on the program of exercises, and had contributed the first paper, under the title "Human Spermatogenesis, Spermatocytes and Spermiogenesis" to the commemorative quarto volume.

At the place where "verbal communications" are usually called for, Dr. Nolan, under the title "Reminiscences," spoke of his connection with the academy as assistant librarian, librarian and recording secretary during the past fifty years, his earliest record of accessions to the library being dated February 4, 1862. He deeply regretted that he had not taken advantage of his acquaintanceship with certain contemporaries of the founders, who were still alive when he entered on the scene, such as George Ord, Jacob Peirce, Isaac Hays and Titian R. Peale to make notes of their recollections of the early days, but it could readily be believed that in his most sanguine moments he had never contemplated the possibility of being called on fifty years

later to record his regret before such an audience. He then spoke of the beginning of his work as an untrained assistant in the library and the unvarying kindness and consideration he had experienced from all the men met with at that time, but especially from his dear chief, J. Dickinson Sergeant, and his beloved future preceptor, Joseph Leidy.

It was an extraordinary epoch in the history of the academy, the beginning of its second half century, and the boy was associated with a stimulating group of men, including Leidy, Cope, Conrad, Tryon, Lea, Slack, Rand, Cassin, Heermann, Meigs, Gabb and Wilson, all men of marked individuality, some of whom have made permanent records as leaders of science in America.

Continuing, Dr. Nolan gave his impressions of some of his contemporaries of later date—Allen, Horn, Meehan, Ruschenberger, Ryder, McCook, Heilprin, Chapman, Isaac Jones Wistar and Arthur Erwin Brown—not by any means dealing in laudation exclusively, but indulging in kindly personalities in a belief that a more intimate tone than would be entirely desirable in a published record would not be disagreeable to his auditors, many of whom were familiar with the work of the men whom he was describing.

In the one hundred years of the academy's history four men had stood out prominently, with, of course, scores of associates, as dominant in its material and intellectual advancement. These were Thomas Say, Samuel George Morton, Joseph Leidy and the present chief executive. The work of Say, Morton and Leidy formed part of the history of the academy, and if impression were desired of the accomplishments of Samuel Gibson Dixon they had but to look around them.

Closing his remarks the secretary was

distressed to remember the names of the many dear friends whom, for lack of time, he was forced to leave in the undesirable class "and others."

Those whom he had known during the first years of association with the academy were nearly all dead. The old building, if it still existed, would be full of ghosts and even in the present halls, in the dusk of the winter days, dear shades encountered him in the alcoves and passageways and reminded him of the time when he too should be a tradition.

In conclusion he remarked:

But in the meantime it is with feelings of profound gratitude that I bear testimony to the kindly patience and sustaining encouragement of those who are still with me and who impart to the performance of the daily task much pleasure and little or no pain.

For obvious reasons I can not deal in personalities in the case of my living contemporaries, but I am at liberty to say that they are worthily taking the place of those who have labored so loyally for the advancement of the academy and who, we are not forbidden by the highest reason to hope, are now rejoicing in this splendid commemoration of their labors. Had they lived when men cherished the same truths under different formulae their motto would have been *Ad maiorem Dei gloriam*.

May the men who come after us be as zealous and as disinterested in the development of truth as those whom I have been so ineffectually remembering to-night, so that when the second centenary is celebrated it also may be the subject of congratulation for a like gathering of kindly and appreciative friends.

Nominations for membership were read, the elections of those formerly proposed being deferred until the next meeting.

The rough minutes were then read for criticism and approval, as had been the custom for nearly one hundred years, the secretary explaining that he had complied with the directions of Dr. Mann and dated the record as having been made in the 137th Year of the United States. No cor-

rections being called for, they were adopted as read and the meeting adjourned until the following morning at 10 o'clock.

Wednesday morning, March 20. The day was sparkling, bright and genial and the hall was filled with delegates, members and visitors when Dr. Dixon dropped the gavel at 10 o'clock. The following papers, most of which were résumés of communications presented for publication in the commemorative volume, were then read:

Edwin G. Conklin, Ph.D.: "Experimental Studies on Nuclear and Cell Division."

Carlotta J. Maury, Ph.D.: "A Contribution to the Paleontology of Trinidad." The memoir will be illustrated with superb drawings of fossils from the accomplished pen of Professor Gilbert D. Harris, of Cornell University.

W. J. Holland, Ph.D.: "David Alter, the First Discoverer of Spectrum Analysis," with exhibition of the prism used by him.

John W. Harshberger, Ph.D.: "The Vegetation of the Banana Holes of Florida," well illustrated by lantern views.

Frederick W. True, M.S., LL.D.: "A New Species of *Delphinodon*."

Henry H. Donaldson, Sc.D., Ph.D.: "The History and Zoological Position of the Albino Rat."

Edward B. Meigs, M.D.: "The Ash of Smooth Muscle."

Marshall Avery Howe, Ph.D.: "Reef-building and Land-forming Seaweeds," illustrated by views and specimens.

At the conclusion of Dr. Howe's paper the audience adjourned to the new geological hall—the old library hall transformed—where a liberal luncheon was enjoyed.

The meeting reassembled at 2:30 P.M., when Benjamin Smith Lyman read a paper on "Natural History Morality." It was followed by the following:

Jacques Loeb, M.D., Ph.D.: "Experiments on Adaptation of Animals to Higher Temperatures."

Henry Skinner, M.D., Sc.D.: "Mimicry in Butterflies."

Spencer Trotter, M.D.: "The Faunal Divisions of Eastern North America in Relation to Vegetation."

T. Wayland Vaughan, Ph.D.: "Rate of Growth of Stony Corals," illustrated with lantern slides.

Henry A. Pilsbry, Sc.D.: "On the Tropical Element in the Molluscan Fauna of Florida."

The session closed with illustrations by means of a superb collection of lantern views, of methods of bird photography by William L. Bailly.

In the evening a reception was tendered the delegates by Dr. Dixon, Mrs. Dixon and Miss Dixon in the Bellevue-Stratford Hotel. In common with everything else on the program it was brilliantly successful.

The weather Thursday morning was a violent and most undesirable change from that of the day before, a fall of snow being driven along by penetrating winds. It was a most gratifying evidence of the earnestness and interest of those attending the sessions that little falling off in the attendance was observable when Dr. Dixon called the meeting to order a few minutes after ten.

He opened the proceedings by referring to the death of Dr. Montgomery, who had been placed first on the program of that session. His place was taken by Edwin J. Houston, Ph.D., who made an interesting communication on "How the Natural Sciences can be made Attractive to the Young."

In continuation the following papers were read:

James A. G. Rehn: "The Orthopteran Inhabitants of the Sonoran Creosote Bush."

Merkel H. Jacobs, Ph.D.: "Physiological Characteristics of Species."

Henry F. Osborn, LL.D.: "Tetraplasy, or Law of the Four Inseparable Factors."

George Howard Parker, Sc.D.: "Sensory Appropriation as Illustrated by the Organs of Taste in Vertebrates."

John M. Macfarlane, Sc.D.: "The Relation of Protoplasm to its Environment."

William H. Dall, A.M., Sc.D.: "Mollusk Fauna of Northwest America."

The time having arrived for luncheon,

two papers were deferred to an afternoon session not provided for on the printed program.

On reassembling at 2 o'clock, Henry G. Bryant, LL.B., read a paper on "Governmental Agencies in the Advancement of Geographical Knowledge in the United States," and the scientific sessions concluded with a superbly illustrated and most interesting lecture by Witmer Stone, A.M., the ornithological curator of the academy, on the "Fauna and Flora of the New Jersey Pine Barrens." The communication was specially enjoyed by those from a distance as imparting in a most pleasing manner information regarding a region of quite unusual physiographical interest.

The rest of the afternoon was devoted to a demonstration of the resources of the museum and library, including a fine display of one hundred and thirty-two microscopes and an exhibition of a portion of the academy's superb collection of butterflies.

In the evening one hundred and sixty members and guests sat down to a banquet in the exquisitely decorated new geological hall, formerly occupied by the library. The occasion will long be remembered as a specially enjoyable one by those present.

Dr. Edwin G. Conklin, professor of biology in Princeton University and one of the vice-presidents of the academy, was an inimitable toastmaster and at his call appreciative speeches were made by the mayor, who sat on the right of the president; Mons. Jean de Pulligny, director of the commission of French engineers to the United States; Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, New York; Dr. Dixon; Dr. Theodore N. Gill, of the Smithsonian Institution; Dr. William J. Holland, of the Carnegie Museum of Pittsburgh, and Dr. Nolan, all bearing testimony to the acad-

emy's influence as a source of inspiration and encouragement.

The celebration of the one hundredth anniversary of the institution which had produced such a marked effect on the progress of science in America finished with the singing of "Auld Lang Syne," the departing guests sympathizing with those who were unable to participate in the hearty and genial conclusion of a program which was unanimously declared to be a complete success.

THE MISUSE OF LANTERN ILLUSTRATIONS BY MUSEUM LECTURERS¹

THE illustrated lecture has long been a very prominent feature of the educational and scientific work of the public museums of this city. It has long been a feature of the meetings of clubs and societies of all kinds, not so much for instruction as for popular entertainment.

So general is the use of lantern illustrations at all sorts of gatherings, that it has become commonplace. It is necessary for the legion of lecturers who employ them to procure better, and yet better pictures, to make their performances attractive. We appear to be in the midst of a great rivalry as to who can make the finest pictorial display, and anybody, apparently, may occupy the platform.

At a recent meeting of ornithologists in Philadelphia, I sat for many hours watching a continuous performance of stereopticon lecturers. Some of them did their parts remarkably well, but the three-days meeting was manifestly, although unconsciously, a lantern-slide competition. During the intermissions, the audience, composed chiefly of professional ornithologists, talked almost entirely of the admirable pictures that had been shown, making animated comparisons of the success achieved by this or that photographer.

There have come among us hosts of skilful photographers or enthusiastic travelers, back

from hasty trips to Zúñi or East Africa, ready to exhibit the best of pictures, to any kind of an audience that they can get, and to talk more or less amusingly while doing so.

Many of these so-called lecturers are successful enough, and audiences are forthcoming anywhere from the Museum of Natural History to the Suburban Entertainment Club. Even Peary's colored cook is doing a rattling lecture business with his master's slides.

Good pictures are dangerous in the wrong hands. Imagine a dull and dreary talker, still talking in public if he were deprived of lantern slides.

The use of lantern slides should be on a safer basis. They should not only be reduced in number, but be partially replaced with something more intellectual.

There could be no objection to lantern pictures as an inexpensive form of entertainment, if it were understood to be chiefly for entertainment, but when a fine collection of pictures of the Grand Cañon, accompanied by the talk of a mere traveler, is announced as a lecture on geology, it is a sign that we are losing our powers of discrimination.

When some superb pictures of Indian habitations on the table-lands of the southwest are described by a mere photographer engaged in making money out of the lantern slides, shall the authorities of the great museum allow the performance to be advertised as a lecture on ethnology? The City Bureau of Free Lectures employs a legion of lantern slide lecturers on travel, some of whom doubtless have never visited the lands they describe in glowing terms. There are art lecturers in this city showing colored photographs of the great paintings of Europe, who have never seen the originals. I am not undertaking to condemn the work of the free lecture bureau. It doubtless affords thousands of people entertainment that is wholesome and not without instruction.

Some of the lecturers make a specialty of describing the wonders of the Art Museum, or the Aquarium, and I personally shouldn't care to lose that much free advertising for my own institution. No doubt the pictures

¹ Part of a paper read at a meeting of curators of the public museums of New York, December 19, 1911.

and talk about art send many persons to the Art Museum.

But shall the museums, holding, as they do, authoritative positions respecting art and science, disregard the fact that the amateur is among us with lantern pictures that may be better than ours? Is it not time to consider whether by continuing as we are doing, we may be cheapening the labors of the distinguished specialists who cheerfully do their part in our own lecture courses?

There are reasons for believing that the general public is pretty well satisfied with what it gets, and also that it is incapable of distinguishing between the noted authority and the mere amateur who has the same kind of pictures. Shall we continue to be satisfied with this kindergarten way of lecturing?

Shall we continue to supply sugar-coated science until even the more discriminating part of the public begins to think that the professional ornithologist is really no better than the enthusiastic amateur who can photograph birds just as well?

While there are many of our number who can lecture most acceptably using lantern illustrations, there are certainly some of us who habitually depend upon the effect of the pictures used. Lecturing with lantern illustrations has so nearly superseded the well-prepared, authoritative discourse, that the latter has become a rarity.

I am convinced that what we have come to call lecturing is not the real thing, that the effect of the present over-illustrated lecture upon the audience is not what it should be.

The presentation is to the eye rather than to the mind, and the audience accepts it with a passive, rather than an active mind. The audience is already lost to the lecturer; he does not see its face, and there is no response to him.

In the experience of most of us, many a slovenly lecture has been tolerated because of the excellence of its illustrations. We continue to endure the indifferent talk of the lecturer, because we seem to be getting our money's worth out of his pictures.

In such a case the lecturer, perhaps a man

of real scientific attainment, has actually degraded himself to the level of a showman. He may even be content with the applause bestowed only upon his achievements as a photographer.

But the audience, too, has degraded itself, by its intellectually languid acceptance. It will eventually tire of even the best of slides, and be satisfied with nothing less exciting than motion pictures.

The effect of the average lantern lecture can be readily judged by any one who cares to hear the remarks of the departing audience: "What splendid photographs," "How beautifully colored." We have all repeatedly heard just these words. The talk is of the *show*, and the self-satisfied showman on the platform has merely cracked the whip and given the signals to the real performer—the stereopticon man.

Let us contrast such a performance in the darkened hall, before an audience of sightseers awaiting the next flash of the lantern, with that of a lecturer addressing the mind of his audience. Imagine Mr. Roosevelt or Beecher or Ingersoll receiving such applause as they have received if they had stood in the dark explaining pictures that might have told their own story. Have not some of our lecturers practically arrived at the point where the automatic lantern, carrying labeled slides, could do the trick as well?

But assuming that we must use pictures, what shall we say of the well-informed lecturer who thoughtlessly turns his back to the audience, and addresses the changing panorama on the screen, so that his weak voice can be heard only by those who sit in the front rows?

What shall we say of the lecturer, who, depending upon his pictures, has not prepared himself to discuss with at least a show of animation what each picture presents, and who can do little more than industriously wield the pointer, and inform his benighted audience that a tree is a tree, and a wild Indian an Indian?

What shall we say of the well-known writer, who, having no gift for extemporaneous speaking, mars the good effect of excellent il-

illustrations by neglecting to use the manuscript that would make his discourse coherent?

Perhaps mere notes would save him from helpless verbal floundering.

What shall we say of that misguided person, who, having at least eighty pictures to illustrate his lecture on Alaska, or some other far-away place, throws in about forty more, to show how he got there? Half a dozen to get the ship away from the dock at Seattle, half a dozen shots at the city as he steams away, a few more at passing vessels, another half dozen at the members of his party (in which he is careful to show up in most of the groups himself), a few pictures of the captain, and about a dozen showing the Indian villages of the British Columbia islands, as he steams kodaking along, and all of which have been kodaked by a dozen tourists on every steamer, every week for the past twenty years.

I witnessed such a performance at the afore-mentioned meeting in Philadelphia. The exhibitor of slides held the platform for an hour and a half, until even the picture-bewitched ornithologists were audibly in revolt.

How shall we use the lantern slide? Is it not possible for the lecturer to first present his matter, so that it will appeal to the mind of his audience, and then follow his discourse with a limited number of illustrations selected for their fitness rather than their beauty? It would be quite useless to show pictures first. No audience will stay after the last picture. The unceremonious exit stampede begins at once, even if the distinguished president of the society has risen to make some concluding remarks.

And how about manuscript which is unfortunately often necessary? There is no need for a slavish use of manuscript, if the matter is good and delivered in a vigorous manner. Many speakers use it effectively. Ingersoll never spoke without it, and Roosevelt uses it for all lengthy discourses.

Our museum lecturer should unquestionably devote more time to preparation. He should make his address worth hearing with-

out illustrations at all. He should be able to get the same applause for his matter that he gets for his pictures. When he does that he will be on a dignified basis himself, and will pay a long-deferred compliment to the intelligence of the audience, that it will be likely to appreciate.

I should like to see some of our museum men doing their platform work without pictures, and I am sure that some of them are capable of doing it. Most of those who try it should write out their lectures in full, and thus get the benefit of the work of arranging their matter and becoming familiar with it.

There must, of course, be reference to the manuscript, but the audience will not mind that if the subject is of real interest and the speaker deals with it in a forcible manner, impressing his hearers with the fact that they are listening to a man filled with his subject and sure that it is a good one. Lack of earnestness means that the audience will get weary or begin to slip out. I am sure that a good lecture half an hour long, followed by half the usual number of illustrations, will be an improvement on the present method.

Should we not illustrate our lectures, and cease to lecture about our illustrations?

C. H. TOWNSEND

N. Y. AQUARIUM

RALPH STOCKMAN TARR

As Cornellians and former students of Professor Ralph Stockman Tarr we learn with sorrow of his death and extend to his family our heartfelt sympathy and condolence. We feel keenly the loss to the university of his unselfish service and forceful personality, and we regret that his brilliant contributions to geology and geography have been cut off at a time when they were most fruitful and convincing. Above all we deplore the loss of the personal influence which we have found so helpful and inspiring in his home, in the classroom and in the field. Those of us who have known him under the trying conditions of life in northern ice fields, where no hardship was too great to be cheerfully borne, can most fully

appreciate his devotion to the science he loved and the fineness and strength of his character.

GEO. H. ASHLEY,	J. C. HOYT,
V. H. BARNETT,	L. O. HOWARD,
J. A. BONSTEEL,	E. M. KINDLE,
B. S. BUTLER,	G. C. MARTIN,
F. K. CAMERON	G. C. MATSON,
M. E. EVANS,	E. S. SHEPHERD,
L. C. GRATON,	C. W. TURRENTINE,
R. T. HILL,	DAVID WHITE
J. A. HOLMES,	

WASHINGTON, D. C.,
March 22, 1912

CHARLES ROBERT SANGER

In the untimely death of Professor Sanger, on February 25, 1912, the Faculty of Arts and Sciences of Harvard University lost a loyal and faithful member, the chemical laboratory of Harvard College an efficient director, and the class of 1881 a devoted secretary.

Charles Robert Sanger was born in Boston on August 31, 1860. He graduated from Harvard College in 1881, received the Harvard degree of Master of Arts in 1882, and attained that of Doctor of Philosophy in 1884. From 1881 to 1882 and again from 1884 to 1886, he was assistant in the chemical laboratory of Harvard College, but in 1886 he went to the United States Naval Academy at Annapolis, as professor of chemistry. Six years later he was called to Washington University, St. Louis, Mo., and remained there until 1899, when he came back to Harvard as assistant professor of chemistry. He was called here because his service as assistant in qualitative analysis fifteen years before had been so able that he was deemed the most suitable person to continue the instruction in this favorite course when Professor H. B. Hill was obliged by other duties to relinquish it. Professor Sanger's return to Harvard was appropriate; he had never lost interest in the varied phases of our university life even when duty called him elsewhere. No son of Harvard has ever worked, according to his opportunity, more loyally in her behalf.

When in 1903 Hill laid down his work for-

ever, Sanger was promoted to a full professorship, and on account of his marked executive ability and conscientious devotion, was the natural choice for the onerous directorship of the laboratory. Only those who have been privileged to work with him there can fully appreciate the extent to which he generously gave his time and thought in order to further the interests of all.

While first at Harvard as an assistant, he worked under Professor Hill on the constitution of pyromucic acid. In recent years he confined his work chiefly to the devising and perfecting of methods for the detection of minute quantities of arsenic, antimony and fluorine, as well as to the investigation of the chlorine derivatives of silicon and sulphur. Besides papers describing these researches, he wrote several laboratory manuals. His fine character was especially manifested in the great care he exercised in all his scientific work; he was determined that no untrue statement should ever escape his pen, and rigorous precautions and manifold repetitions of experiments doubtless prevented him from ranging over a wider field. As a teacher he tried to inculcate the same habits of methodical painstaking work which he possessed himself.

He was a Fellow of the American Academy of Arts and Sciences and a member of the American Chemical Society and the Deutsche Chemische Gesellschaft.

In 1886 he married Miss Almira Starkweather Horswell, who died in 1905, leaving three children. Five years later he married Miss Eleanor W. Davis, of Cambridge, who, with the children, survives him.

No one could watch his struggle against an insidious disease during these last years without a feeling of deep admiration for the courage with which he lectured and worked in spite of spasms of mortal pain and prostrating weakness; and the devotion and consideration of his classes was a striking testimony to the universal respect in which he was held.

T. W. RICHARDS,
B. O. PEIRCE,
G. P. BAXTER

SCIENTIFIC NOTES AND NEWS

SIR J. J. THOMSON has been appointed by King George V. a member of the order of merit. The other scientific men who are members of the order are Lord Rayleigh, Dr. A. R. Wallace and Sir William Crooks. The order has recently lost through death Sir Joseph Dalton Hooker and Lord Lister.

DR. GEORGE T. MOORE has been elected director of the Missouri Botanical Garden to fill the vacancy caused by the resignation of Dr. William Trelease.

It is expected that the Peter Bent Brigham Hospital, now under construction on land adjoining the Harvard Medical School, will be completed in October, 1912. Dr. Henry A. Christian, retiring dean of the Harvard Medical School, will be physician-in-chief, Dr. Harvey Cushing, of the Johns Hopkins Medical School, surgeon-in-chief, and Dr. H. B. Howard, superintendent.

PROFESSOR ARTHUR SEARLE, Phillips professor of astronomy at Harvard University, has presented his resignation after a teaching service at the university of forty-two years. He graduated from Harvard in 1856.

PROFESSOR JEAN GASTON DARBOUX and Professor Elias Metchnikoff have been elected honorary members of the Royal Irish Academy in the section of science.

DR. JUST LUCAS-CHAMPIONNIÈRE has been elected a member of the Paris Academy of Sciences in succession to the late Professor Lannelongue.

THE council of the British Iron and Steel Institute has awarded the Andrew Carnegie Gold Medal of the Institute to Dr. Paul Goehre, the metallurgist of Aachen.

DR. C. L. SHEAR, pathologist in the Bureau of Plant Industry, has sailed for Europe to spend several months in the investigation of fruit diseases.

DR. J. E. POGUE, assistant curator of mineralogy, U. S. National Museum, has returned to Washington after a three months' research and study trip in Europe.

DR. HERBERT M. EVANS, of the Johns Hopkins Medical School, has been granted leave of absence to go abroad to work in the laboratory of Professor Ehrlich, at Frankfort, during the coming summer.

DR. DOUGLASS WILSON JOHNSON, of Harvard University, who has recently been appointed associate professor of physiography at Columbia University, is spending a half year in Europe.

DR. FRANK BILLINGS, professor of medicine at the University of Chicago, has been appointed to provide the details of the program for the section of epilepsy of the State Conference of Charities and Corrections to be held in Chicago next October.

MR. E. J. MCCAUSTLAND, professor of municipal engineering in the State University of Washington, has been appointed a member of the State Board of Health. Professor McCaustland has for three years acted in the capacity of consulting sanitary engineer to the board.

In the preliminary list of papers to be presented at the eighteenth international congress of Americanists to be held in London, beginning on May 27, there are titles from the United States by Dr. Franz Boas, of Columbia University; Dr. A. Hrdlicka, of the U. S. National Museum; Dr. Charles Peabody, of Harvard University; Mr. Stansbury Hagar, of New York.

PROFESSOR JOSEPH P. IDDIGS, of Washington, will deliver a course of lectures to the geological students of the Johns Hopkins University, on "The Problems of Petrographical Provinces." The lectures will be given during the last two weeks in April.

THE REV. CASPAR RENÉ GREGORY, professor of theology in the University of Leipzig, has concluded a special course of lectures at Western Reserve University. The lectures included a series of six on the subject "Five Hundred Years of Science in Leipzig."

THE Society for Biological Research of the University of Pittsburgh held, on March 20, its second special meeting for the year 1911-12, at which time Dr. Robert Russell Bensley,

director of the Hull Anatomical Laboratories of the University of Chicago, gave an address on "The Structure of the Pancreas and its bearing on the Islet Theory of Diabetes."

THE twentieth "James Forrest" lecture will be delivered at the Institution of Civil Engineers on April 19, by Mr. H. R. Arnulph Mallock, F.R.S., his subject being "Aerial Flight."

SIR WILLIAM MACEWEN will give an address on Lord Lister at the meeting of the Royal Institution of Great Britain on Friday evening, June 7.

A PORTRAIT bust of the late Sir Joseph Hooker, from a sitting taken just before his death, has been completed by Mr. Pennachine.

THE funeral of Dr. Thomas H. Montgomery, Jr., professor of zoology in the University of Pennsylvania, was held on Friday, March 22, at St. Mary's Episcopal Church. The honorary pallbearers were: Provost Smith, of the University of Pennsylvania; ex-Provost Charles C. Harrison; Professor E. G. Conklin, of Princeton University; Professor G. H. Parker, of Harvard University; Professor J. P. Moore, of the University of Pennsylvania; Professor W. M. Wheeler, of Harvard University; Professor William R. Newbold, of the University of Pennsylvania; William S. Morris and Professor Philip P. Calvert, of the University of Pennsylvania.

DR. JAMES RUFUS TRYON, formerly medical director of the navy, retired with the relative rank of rear-admiral, has died at the age of eighty-two years.

THE late Lord Wandsworth has bequeathed over a million pounds to establish an orphanage and school; the will also contains a bequest of £10,000 for medical research.

MISS HELEN SWINDELLS, of Southport, has bequeathed £5,000 to the University of Manchester for cancer research, and £5,000 to the benevolent fund of the Institution of Civil Engineers.

THE John Hay Library at Brown University will be augmented by a collection of seven thousand volumes on engineering subjects,

the gift of Mr. Elmer L. Corthell, the hydraulic and waterways engineer. The gift of the Corthell Library, as it is to be known, carries with it an endowment fund of \$5,000.

A SERIES of prizes is offered by a member of the Torrey Botanical Club for the best popular article on some feature of the vegetation of the local flora range. The prizes will be as follows: (1) A first prize of \$25; (2) a second prize of \$15; (3) for the five next best articles, a year's subscription to *Torreya*. (Offered by the club.) The competition is open to all amateurs, school teachers and others not on the staff of a botanic garden, college or university.

THE fifth session of the Graduate School of Agriculture will be held under the auspices of the Association of American Agricultural Colleges and Experiment Stations, at the Michigan Agricultural College, East Lansing, Mich., July 1-26, 1912. Director A. C. True, of the United States Office of Experiment Stations, will be dean of the school and the faculty, as usual, will consist of some of the leading scientific men from the United States Department of Agriculture, the American agricultural colleges and experiment stations, other American universities and European institutions. Two lecturers have been secured from England, Dr. A. D. Hall, of the Rothamsted Experiment Station, and Professor F. H. A. Marshall, Christ College, Cambridge University. This school is open only to college graduates who want to pursue advanced work in agriculture. Graduate courses will be given under the general head of soils and plant physiology, animal physiology, agronomy, horticulture, swine husbandry, poultry husbandry, beef and dairy cattle, rural engineering and rural economics. Among the more important topics that will be given consideration at this time are the part played by the soil solution in the nutrition of plants, the relation of the physiology of plants to the soil problem, colloids in relation to soil fertility and soil bacteriology, zootechnical problems in relation to the physiology of the cell, the physiology of reproduction and the biology of sex, plant production

problems in relation to plant breeding and adaptation, problems dealing with the transportation, handling and storing of fruit, rural sanitation, road making, rural social surveys and rural festivals as agencies for social contact.

THE department of electrical engineering of the Massachusetts Institute of Technology has under way an important investigation on the adaptability of electric vehicles for trucking purposes, more especially with reference to the conditions in Boston and its vicinity. Mr. H. F. Thomson, the research associate, in carrying on this work, is making substantial progress in the inquiry. The inquiry is directed along several particular lines, including cost of the service, convenience of the service, difficulties and expenses due to the delays in loading and unloading at freight houses and the like, delays caused by drivers, and corresponding matters. The railroads entering Boston are cooperating with the part of the investigation relating to time occupied in loading and unloading trucks at the freight houses, including the time occupied in getting to the loading platform. The freight house conditions are being investigated by students of the department under the direction of Mr. Thomson. An appropriation for this work was made to the institution by the Edison Electric Illuminating Company of Boston. The research was begun about the middle of the year 1911 and is expected to extend beyond the year. It is expected to result in a report or series of reports on the relative merits of electric vehicles, other mechanical vehicles and horse vehicles for city and suburban delivery, for trucking and for the other purposes for which vehicles are used in the city and its suburbs. The department has had erected in Brookline a 700 foot span of number two naught bare stranded wire to represent a transmission span on towers, and has had this span under observation during the severe weather of this winter. The object is to learn more exactly the effects of ice, sleet and wind loads, and of temperature effects on the stresses imposed upon the wire and its supports. This research is being carried on by two students under the

direction of Professor Harold Pender. There are now a larger number of candidates for advanced degrees in electrical engineering than the department has ever previously seen, and the various branches of research which are being carried on are being constantly enlarged. This is in addition to the extended undergraduate work for which the department is notable.

THE copper mines of the United States have produced more than fifteen and a quarter billion pounds of copper, and of this total twelve mining districts have produced in excess of 100,000,000 pounds each, according to the United States Geological Survey. These twelve districts, located in eight states, have yielded 94.69 per cent. of the total output of the country since 1845, when the total product of the United States was but little more than 200,000 pounds. These districts are Butte, Mont., which has yielded 5,315,000,000 pounds, or 34.75 per cent. of the total production; Lake Superior, Mich., which has yielded 4,756,000,000 pounds; Bisbee, Ariz., 1,285,000,000 pounds; Morenci-Metcalf, Ariz., 882,700,000 pounds; Jerome, Ariz., 570,000,000 pounds; Bingham, Utah, 465,000,000 pounds; Shasta County, Cal., 336,000,000 pounds; Globe, Ariz., 334,700,000 pounds; Ducktown, Tenn., 211,700,000 pounds; Ely, Nev., 125,000,000 pounds; the foothill belt, California, 104,000,000 pounds; and Santa Rita, N. Mex. (where mining is believed to have been begun as far back as 1800), 103,000,000 pounds. All other districts have produced 804,300,000 pounds. It is interesting to note that the first ten of these districts are also the first ten largest producers to-day, although the order is slightly changed. These ten districts yielded 93.84 per cent. of the production for 1910. The United States is by far the greatest copper-producing country, our smelter output of copper in 1910 being 56.75 per cent. of the total for the world. Nearly every one of the leading copper-producing districts of the United States, according to the Geological Survey, made a record output within the three years preceding 1910, and nearly every one of them could have done so in 1910 so far as the ability of the mines

to produce the ore was concerned. An indifferent copper market and metallurgical difficulties, however, resulted in a decrease in the output for 1910 for several districts. The Survey's estimate on January 2, 1912, indicates a copper output for 1911 greater than that of 1910 and nearly equal to the record production of 1909. It is further stated that most of the companies are now in a position to maintain or even increase their present output, so that, if the consumption of the metal will permit, the production of copper in the United States for 1912 may be expected to show a marked increase. It is noteworthy that not one of the leading copper districts of the United States, several of which have been active producers for 30 years or more, has been worked out or shown a decrease in its ability to produce copper.

UNIVERSITY AND EDUCATIONAL NEWS

AN anonymous gift of £100,000 has been made toward enabling the University of London to acquire a site north of the British Museum. The university has also received £60,000 from the Draper's Company for a senate house and administrative offices.

AN anonymous donor has undertaken to give £20,000 to the University of Cambridge, to establish a chair of genetics, to be called the Balfour professorship of genetics, in honor of Mr. A. J. Balfour.

THE nomination is announced of Dr. Edward H. Bradford, A.B. (Harvard, '69), professor of orthopedic surgery, to be dean of the Harvard Medical School.

PROFESSOR GEO. M. REED, of the University of Missouri, will have charge of the botanical work in the New York University during the summer session of 1912.

PROFESSOR H. A. WADSWORTH, of the department of forestry, University of Idaho, has resigned to accept a commission in the United States army. Mr. Erwin W. Cook, B.S. (Washburn), M.F. (Michigan), has been appointed instructor in forestry at the university. He has been forest assistant on the Salmon (Idaho) National Forest for the past two years.

DISCUSSION AND CORRESPONDENCE

PRINCIPLES OF WATER-POWER DEVELOPMENT

TO THE EDITOR OF SCIENCE: In presenting "Another View of the Principles of Water-Power Development,"¹ Professor Aldrich illustrates his idea of individual ownership of water in part by the pronouncement, "A man owns the water in his well, we all believe." He utterly ignores the case (occurring with increasing frequency as population and industrial use of water advance) in which the sinking of a larger or deeper well in the neighborhood robs the earlier well of its supply; and he equally ignores all other of those physical facts and relations concerning water which are of growing consequence and complexity as the uses of this primary resource increase and multiply.

Professor Aldrich illustrates his view of equity in the use of water by reference to power development at Shoshone Falls and Twin Falls, and declares that the only "part of the people" of the United States equitably interested in this use are "simply those who live within the range of power transmission, and are not more accessible to another source of power." He utterly ignores the paramount uses of water for domestic supply and the production of food; he ignores the patent fact that each year and each decade more and more of the water of Snake River is removed for these paramount purposes, and the certainty that within a generation practically all the water of Snake River valley will be consumed for these paramount purposes, leaving only a sufficient flow for natural sewerage with incidental power development and navigation; and he equally ignores the broad fact that "the people of Cape Cod, or of Washington, D. C.," who consume bread and beet sugar and other products of Snake River valley, have a most real interest in such utilization of the waters of that river as will best promote normal production and industrial development—i. e., as will best contribute to the general welfare. Perhaps the clearest indication of Professor Aldrich's no-

¹ SCIENCE, March 1, 1912, pp. 338-340.

tion as to equities in water appears in the pronouncement that under common ownership "the general government should collect as a tax" on all users of water amounts which may be defined broadly as corresponding to the railway standard of "what the traffic will bear"; he ignores the fundamental economic principle that while common ownership implies the right to impose conditions of distribution and use, it involves primarily the obligation to minimize taxes or other costs of distribution in the common interest.

In pointing his views as to the finality of legal relations already developed in the west, Professor Aldrich declares, "Every western state has voluminous laws on the subject, and ten times more voluminous legal decisions on those laws." Were his familiarity and sympathy with the west still greater than he professes, he would realize that the Idaho water law is better than that of Wyoming after which it was modeled, that the later Oregon law is still better, and that the California water law enacted a few months ago is the best of all, since with each passing year growing knowledge as to physical facts and relations, increasing population and industries, and concurrently advancing standards of equity fall into closer accord—indeed he would realize that the very principles he criticizes are the outcome of experience in the west, where the natural water supply is so meager that it is necessarily measured and apportioned and utilized more carefully than in any humid land, and might even learn that the proposition *All the water belongs to all the People* was first crystallized and expressed through the National Irrigation Congress (an essentially western organization, made up of western men, dominated by western ideas) at a meeting in Spokane wherein the preponderating representation was from Washington, Idaho, Montana and Oregon.

To those unfamiliar with the situation it may be of interest to know that two opposing views concerning the administration of water and other resources have come up in the western states; the formerly prevalent but now minority view is that the resources shall

be exploited for the private profit of those who acquired possession before their value was realized; the later view, already held by the great majority, is that the resources shall be developed, conserved against needless destruction, and utilized in the common interest, under customs and laws established primarily by communities, secondarily, by states, and finally, as need arises, by the federal government. On these opposing views Professor Aldrich contributes polemics, which may be needful pending more specific knowledge; but it is to be regretted that he does not contribute a fact, a figure, a principle, or any other iota of that definite foundation on which alone scientific discussion may fitly rest, and on which sound legislation may eventually be erected—unless, indeed, he is right in his remarkable main contention that the western states, commonly considered the most actively-growing part of the country, are already so bound by statutes and decisions that further progress is impossible.

W J MCGEE

DR. RADOSAVLJEVICH'S "CRITIQUE" OF PROFESSOR BOAS

TO THE EDITOR OF SCIENCE: The number of the *American Anthropologist* just issued from the press (Vol. 13, 1911, No. 3) contains an article by Dr. Paul R. Radosavljevich entitled "Professor Boas's New Theory of the Form of the Head—a Critical Contribution to School Anthropology" (pp. 394-436). The admission of such an article into a respectable scientific journal seems to have resulted from a misapplication of the praiseworthy editorial principle that no student, however high his professional standing, shall be exempt from the most rigorous criticism on the part of the least of his fellow-workers. In the present instance, however, we have to deal not with a critique, but with a lampoon. The extraordinary character of Dr. Radosavljevich's paper requires an immediate reply, especially in view of Professor Boas's protracted stay in Mexico. Without desiring to forestall a fuller rejoinder by those more

competent to speak on the subjects under discussion, I regard it as necessary to illuminate in a preliminary way the nature of the "contribution" that seeks to brand one of the most critical scientific thinkers of the age as an irresponsible sensation-monger incapable of the most obvious precautions against errors of observation and interpretation. I will confine my attention to two points: (1) Dr. Radosavljevich's representation of Professor Boas's theory; (2) Radosavljevich's refutation of "Boas's first conclusion."

1. Dr. Radosavljevich writes (p. 405):

On page 32 of his [Boas's] report¹ he says that no evidence has been collected which would show an actual change in type due to the direct influence of environment, because the type of immigrants changes from year to year, owing to a selection which is dependent upon the economic conditions of our country, "far-reaching" changes in "type" which "can not be ascribed to selection or mixture." According to Boas the racial characteristics do not survive under the new social and climatic environment of America. We may therefore call Boas's theory the *environmental-economic* theory, the first theory of its kind; *environmental*, because it claims that the descendants of the European immigrants change their type "even in the first generation almost entirely." . . .

The theory may be called *economic*, because it claims that the panics of 1893 and 1907 caused a "sudden decrease in the general physical development of immigrants" and a "sudden" increase in the cephalic index.

A comparison of page 32 of Boas's report with the exposition just quoted at once absolves Dr. Radosavljevich from the charge of morbid devotion to accuracy of statement. On page 32 Professor Boas has nothing to say of the economic conditions of our country; nor is there a word on the causal connection between changes due to environment and the change in type of immigrants due to economic selection. In the first paragraph of page 32 Professor Boas states that the form of the body seems to be the most stable characteristic of any given race, but that Gould and Baxter,

¹"Changes in Bodily Form of Descendants of Immigrants," Washington, 1910.

Bowditch and others have found indications that under more favorable environment the physical development of a race may improve. Then follows the statement:

No evidence, however, has been collected which would show an actual change in type due to the influence of environment. Where changes of this kind seem to occur—as, for instance, in a comparison of the types of city population and country population in southern Germany and in Italy—the inclination of observers has been rather to attribute the difference either to the selective elimination of the weaker type or to the immigration of different types.

After a brief transitional sentence Boas then, in the final paragraph of the page, proceeds to characterize the contribution to knowledge made through his own investigation as compared with the contributions of his predecessors as previously summarized: while *they* had collected no evidence showing an actual change in type due to environment, but were inclined to ascribe changes to selection or mixture, *Boas* has demonstrated "a far-reaching change in the type—a change which can not be ascribed to selection or mixture, but which can only be explained as due directly to the influence of environment."

Our comparison makes it impossible to characterize Dr. Radosavljevich's exposition of page 32 in parliamentary language.

What, then, of Boas's "economic" theory? This, it may be well to mention, is a favorite butt of Radosavljevichian sarcasm (pp. 415, 420, 426). The fact of the matter is that, on page 28 of his "Report," Boas states that after the panic of 1893 a sudden decrease in the general development of immigrants occurred and persisted for several years; that a similar change *seems* to have occurred after the panic of 1907, and that his observations on this point have been confined to East European Hebrews. On page 30 we learn that among the questions not yet studied by Boas, is "the important problem of the selection which takes place during the period of immigration, and which is indicated by the change of type of immigrants after the panics of 1893 and 1907." On page 39 Boas again calls at-

tention to the drop of all absolute measurements of foreign-born Hebrews arriving in America after 1894.

An attempt to combine all the material, adult and children, for these years, brings out the sudden drop after 1893 even more clearly; and a similar phenomenon is repeated between the years 1907 and 1909. For this reason I am inclined to believe that the type of immigrants is directly affected by financial panics. This can be due only to a selection which takes place in Europe, and which may also be affected by the return emigration from the United States to Europe. The material, so far as it has been discussed, does not give a definite answer to this important question, the solution of which would require a series of parallel measurements taken in Europe.

Were there any possibility of misunderstanding the foregoing statements, it would be eliminated by the legend of Boas's Fig. 17:

The most striking feature of the diagram is the general decrease in all measurements in the period following the year 1894, which indicates that the arrivals during the period following the panic of 1893 were underdeveloped in every direction.

When Radosavljevich reproaches Boas for not studying the effect of American soil and financial panics on the same individuals during a period of time representing the age of his subjects (p. 420 f.), he shows that he has not the faintest notion of what Boas is discussing in connection with financial panics.

Unfortunately those who attended a meeting of the American Ethnological Society on March 27, 1911, will be unable to accept this relatively favorable view of Dr. Radosavljevich's attitude towards the "economic" theory. For at that meeting Dr. Radosavljevich, in the course of a lengthy paper, presented a temperate, and formally quite unexceptionable, criticism of what he conceived to be Boas's economic theory. In a discussion Professor Boas pointed out that the criticism rested on a misunderstanding, and Dr. Radosavljevich then—in the presence of Professor Farrand, Drs. Spinden, Goldenweiser and Fishberg, the present writer, and other anthropologists—publicly apologized for his misinterpretation with much profusion of courtesy.

This circumstance seems to have escaped Dr. Radosavljevich's memory.

2. Dr. Radosavljevich asserts that Boas's own observations do not support his theory of a change of type (pp. 406-411, 429). For, says he,

All Hebrews (born in America and in different countries of Europe) are of the same sub-brachycephalic type. Not one age, not one sex, not one individual of Hebrew nativity is represented either by dolichocephalic or by mesocephalic type. The same is true in its way of the Sicilians measured. They are of a high mesocephalic type, both in America and in Europe.

It would be difficult to find in the whole range of scientific literature a more naïve instance of conceptual realism. For Radosavljevich the conventional classificatory divisions of head forms obviously have an absolute biological value. Boas states that foreign-born Hebrews have an index of 84, American-born Hebrews an index of 81. That this difference is a *real* difference results, of course, not from a mere inspection of these two figures, but from the customary statistical treatment of the series involved. But Radosavljevich's mind is undebauched by statistical method. What matters a change of 3 units in the cephalic index so long as "the bulk of both American-born and foreign-born Hebrew boys and girls belong to the same brachycephalic (or rather to the sub-brachycephalic) type"? Sub-brachycephaly ranges from 80 to 86.9. Had Boas found that American-born Hebrews had an index of 79.9, then, we may presume, Dr. Radosavljevich would have hailed the result as the discovery of an actual change of type, provided only that foreign-born Hebrews had an index of 80.001!

As the subject of head forms has an esoteric tang, it may be well to illustrate the logical point at issue by statures. Suppose that we class men below 5 feet 8 in. as short, above 6 feet as tall, and between these limits as middle-sized. Assume further that a race which in Europe has an average height of 5 feet 3 in. adds three inches to its stature in America. Then, according to the classifica-

tory realism of Dr. Radosavljevich, we should not be justified in asserting that a difference in type had taken place, for both statures, 5 feet 3 in. and 5 feet 6 in. fall within our category of shortness. As a matter of fact, it depends entirely on the statistical comparison of foreign-born and American-born individuals (involving the numbers of cases and standard deviations) whether the difference is a real one. A difference of 1 cm. may constitute an actual difference of type in the statistical sense.² Dr. Radosavljevich's inability to grasp what Boas means by "a change of type" and in his insistence on dragging in the irrelevant conventional classification of head forms must be regarded as pathetic.

I believe I have sufficiently elucidated the nature of Dr. Radosavljevich's contribution. I should gladly have refrained from any comment, were it not for the regrettable fact that there are so few anthropologists in America who are able to form an intelligent opinion on the issues involved, and that the uninitiated are liable to be deceived by Dr. Radosavljevich's imposing array of bibliographic references.

ROBERT H. LOWIE

AMERICAN MUSEUM OF NATURAL HISTORY

REPORT OF THE SEAL COMMISSION

TO THE EDITOR OF SCIENCE: In a recent debate in the House of Representatives on the fur seal bill, Congressman N. E. Randall, of Iowa, made the following statement, as reported in the *Record*, p. 2158:

Dr. David Starr Jordan wrote a book. He appropriated this chart of Professor Elliott's and incorporated it into his book as his own. Dr. William T. Hornaday, of New York, subsequently wrote a book. He saw Dr. Jordan's book containing this Elliott chart, and Dr. Hornaday reproduced that chart in his book crediting it to Dr. Jordan. About that time Professor Elliott became alive to the situation and wrote a letter of protest to David Starr Jordan. Dr. Jordan was compelled to admit the plagiarism of the chart and that Dr. Elliott was the author of it and the discoverer of the facts it exhibits.

² Westergaard, "Die Grundzüge der Theorie der Statistik" (Jena, 1890), p. 187.

This charge of plagiarism is so specific and circumstantial that it demands an answer. The chart referred to is doubtless the one printed in the back of the first preliminary report of the Seal Commission of 1896-7, of which Dr. Jordan was chairman. As secretary of the commission I am familiar with the circumstances. When the manuscript of the report was submitted to the Treasury Department, Mr. Charles S. Hamlin, then assistant secretary, suggested the advisability of a chart or map giving the relative location of the Seal Islands and showing the general migration route of the herd. The commission had in process of preparation, under the direction of Mr. Charles H. Townsend, for its final report, an authentic chart of the herd's migration route to be platted from the log records of numerous sealing vessels, but this could not be got ready in time for the preliminary report, and Dr. Jordan was averse to publishing a merely conjectural chart. The assistant secretary held that such a chart, even if not strictly accurate, would be useful to the general reader and indicated how it could be readily compiled from the records of the department. Dr. Jordan acquiesced in this arrangement and left the entire matter of the preparation and printing of the map to the department. He did not see the chart until it appeared in the printed report. That the chart appears without legend as to authorship or source was explained by the fact that it was prepared by the department's own draftsmen and from its own data. Furthermore, the chart contains no information which was not at that time the common property of any one having a general knowledge of the subject. It consisted of a series of curved lines emanating from the passes of the Aleutian Islands, sweeping down through the North Pacific Ocean, veering toward the American coast and returning to the Aleutian passes and thence to the Pribilof Islands, the winter months being printed in the series of lines at points supposed to mark the progress of the herd. How completely this chart was superseded by Mr. Townsend's records platted from some 120 sealing logs will be seen by reference to his

chart published in volume 3, p. 234, of the final report of the commission. That any one should claim authorship for this discarded chart is remarkable. Certainly Dr. Jordan never has. When, after a number of years, Mr. Elliott laid claim to it, Dr. Jordan was assured by the Treasury Department that it was under no obligations to Mr. Elliott for the chart.

GEORGE A. CLARK

STANFORD UNIVERSITY,
February 28, 1912

QUOTATIONS

LORD LISTER AND WESTMINSTER ABBEY

It is only by reason of Lord Lister's known wish that he is not buried in Westminster Abbey. Yesterday an impressive service was held there to give expression to feelings of gratitude and thankfulness, and in memory of what he has done for mankind. Posterity does not always confirm the opinion of contemporaries as to those meriting such honor. The Abbey has its monuments of the pseudo-great, statutes of justly forgotten worthies, inscriptions pretentious if not mendacious. If there were a centennial expurgation, much might be cast out. But of this we may be assured, that it would have been matter of enduring surprise and reproach if no place had been offered in the Abbey for the great healer who has passed away. It is crowded with memories or associations of strife and enmities, and heroism displayed therein. The world does not fight every day as of old, at all events with enemies of one's own race; and so, as time goes on, if the Abbey is to continue to be the place where the nation's chief worthies repose or where it bids them farewell, it must be associated more and more with the heroes and victims of peace. He who cured where death had been certain, who brought hope where there had been despair; he who found surgery, as some thought, little more than the art of killing quickly those who would have died slowly, and who transformed it into a wellnigh miraculously beneficent agency for the relief of human suffering—he, of all others, merits such honor. We are not under-

valuing the ceremony of yesterday—one of the most impressive ever held in the Abbey; one in which every one present was a sincere mourner—in saying that there will be many unseen and nameless tributes of gratitude which Lord Lister would have valued even more. In every hospital, the world over, must be some who, the subjects of operations successfully conducted by reason of his methods, will, on the news of his death, think of him with gratitude. The victories of war are fleeting; they may be over in a day or an hour; and some of the greatest of them are local in their effects. But those of the healing art, such as were due to Lister, are renewed everywhere and for all time.

There exists no means of measuring, even approximately, the amount of pain and suffering in the world at any given time. We can not doubt that it varies from age to age; and there is no certainty that it decreases with the growing complexity of our every-day life. While some primitive sources of suffering, such as famine, pestilence and war, may diminish, others may increase. The hurry and tear and wear incident to our civilization make more calls upon the nerves; they are always on the stretch; and it is not improbable that we are more susceptible to pain than were our rude ancestors. It is the drawback of so many discoveries and inventions that they take away from us almost as much as they give; they create unrest and multiply needs; they spread the limited capacity for pleasure over many objects, to the impairment in the end, it may be, of the total amount of enjoyment; and the greatest marvels of ingenuity may leave us no richer in essentials than before. The inventor who robs us of nothing, whose gifts are all pure gain, is the healer who has found secrets before unknown. In life the presence of pain is the mystery of mysteries. The moralist offers us his feeble explanations, and tells us that without sacrifice no permanent satisfaction or truly good results can be attained; that, to use a common and unconvincing expression, it is a masterful and wholesome discipline; that, to cite the words of one who in all sin-

cerity expounded this unsatisfying solution, by pain we are "driven ever onwards." Such consolations have stifled few cries or groans. The fact borne in upon all who were familiar with surgery in the pre-Lister days was that there was so much suffering to all appearance sheer waste; a heavy price was paid and nothing was gained; the way through discomfort and distress lay to more of both. And so we all instinctively place masters of the healing art, certainly those who have found new remedies and effective methods, among the great benefactors of men. They, and almost they alone, among inventors and discoverers have given much and taken from us nothing.

One further reflection must have been present to many in the Abbey yesterday. Lord Lister's discoveries and methods have opened up possibilities of still further advances, scarcely dreamed of before. The surgeon whom our ancestors regarded as the most highly paid of executioners is seen to be the possessor of an art the future of which is limitless. Lister and his coadjutors have shown what are the enemies to be guarded against and how they are to be encountered. He has opened a way which will be pursued, it may be confidently expected, with signal results. To use the words of the anthem yesterday, "His body is buried in peace, but his name liveth for evermore"; chiefly, no doubt, for his beneficent discoveries, but partly also by reason of the memory of his character, for all time the type of the faithful servant of science. Good as well as great, modest, genial, zealous in the interest of his patients, seeking truth unweariedly and calmly, he will, we do not doubt, be the model and example of men who will carry the art of healing far beyond the point which it has to-day reached.—*The London Times*.

SCIENTIFIC BOOKS

The Chemistry of the Radio-Elements. By FREDERICK SODDY. Longmans, Green and Co. 1911. Pp. 92.

There is probably no branch of modern science which has offered so great an attraction to the casual student as the subject of radio-

activity, and there is certainly none which has afforded a more unrestricted field to the ambitious author who, with but little first-hand information, has been eager to popularize the views of others or to support enthusiastically unsound doctrines based on a wholly insufficient knowledge of the fundamental principles or the value of experimental evidence. It is a pleasure therefore to be able to welcome the appearance of Mr. Soddy's book, written as it is by one who possesses so wide a knowledge of the topics treated and who has played so important and prominent a part in the development of the subject of radioactivity.

The book begins with a brief statement of the scope and objects of radio-chemistry. This is followed by a general discussion of the phenomena of radioactivity, the first discovery by Becquerel of the emission of characteristic radiations by uranium compounds, the general properties of these radiations, and the extension of our knowledge which resulted from the pioneer work of Madame and Monsieur Curie. To the novice in the subject, the text at this point is likely to lead to a somewhat exaggerated notion of the part played by the Curies in the development of the general theory, but difficulties of this sort are apt to arise in any attempt at a condensed treatment of so complex a subject, and the author has succeeded in preparing a distinctly instructive outline in which the more important facts are presented in a clear and orderly fashion. The characteristic differences in the relative permanence or stability of the different radio-elements are mentioned, the production by certain of these of gaseous radioactive elements or emanations is described, and the properties of the emanations themselves are briefly considered. Then follows a discussion of the interesting experiments on the radioactivity of thorium salts, which led to the formulation of the disintegration theory, and an outline is given of this theory in its more important phases.

The next topic treated is the general nature of the three types of radiation, the alpha, the beta and the gamma rays. The characteristic

properties of each of these are considered at some length and the evidence pointing to the identity of the alpha particles with charged helium atoms is clearly presented.

The second chapter is devoted to the radioactive constants and periods of average life of the radio-elements. Here, as elsewhere in the pages which follow, Mr. Soddy has shown a preference for denoting the relative stabilities of the different radio-elements by their so-called "average life" periods rather than by their "half-value" periods adopted and used by nearly (if not quite) all the other writers on the subject. To the reviewer the "average life" of a radio-element is merely the reciprocal of the constant of radioactive change, an occasionally convenient mathematical expression having little or no objective significance. Mr. Soddy defines it as "the sum of the separate periods of future existence of all the individual atoms divided by the number in existence at the starting point." The "half-value" period, on the other hand, is the time required for exactly one half of any given quantity of a radioactive substance to disintegrate or be transformed into other types of matter.

A very interesting and suggestive section on radioactive equilibrium completes the second chapter.

The title of the third chapter is the "Classification and Nomenclature of the Radio-elements.—Analogies Between the Three Disintegration Series," but the subjects covered are much more comprehensive than this heading would imply and include many topics of extreme interest and importance. In the opinion of the reviewer this chapter is the most valuable and illuminating portion of the entire book and the one to be most profitably extended and developed in future editions. It contains the essence of a new branch of science, radiochemistry, and Mr. Soddy has succeeded in collecting together and presenting in a relatively small space, and in a very impressive and convincing manner, much that has previously been accessible only in scattered scientific publications of his own and of other workers in this field of scientific in-

quiry. Thus, for example, the conditions determining the possibility of separating and isolating any given radio-element in a state of comparative purity are briefly but comprehensively considered, the general methods of obtaining the so-called "active deposits"—the solid radioactive products resulting from the disintegration of the gaseous emanations—are outlined, and the inferences to be drawn as to the true chemical nature of the different radio-elements from a knowledge of the behavior of these when mixed with large proportions of their apparent chemical analogues are discussed in some detail.

This general introductory matter occupies in all only thirty pages and one can not avoid a feeling of regret that it was not found practical to extend it still further. It is followed by a systematic presentation of the more important physical and chemical properties of the thirty-odd radio-elements thus far identified arranged in an orderly fashion under the separate headings, "Uranium," "Uranium X," "Ionium," "Radium," etc.

Mr. Soddy has provided us with a very valuable book of its kind, unique in respect to the field which it covers. It need scarcely be added that no one who desires to work intelligently in this modern branch of chemistry can well afford to be without it.

B. B. BOLTWOOD

Stability in Aviation: an Introduction to Dynamical Stability as Applied to the Motion of Aeroplanes. By Professor G. H. BRYAN, Sc.D., F.R.S. Macmillan and Co. 1911. Pp. xi + 192. Price, \$2.00.

Any one seriously at work on the theory or the art of aviation would profit by reading what he can of this book, though precious few will have both the time and the ability wholly to master it and probably none, not even the author of it himself, fully to solve all the difficult problems it sets.

The first chapter gives, in 18 pages of concise non-mathematical language, a summary of existing knowledge on aeroplane stability, and incidentally forms a good mental appetizer for the very solid intellectual courses that fol-

low. But the busy man and the man without mathematical training must take the statements of the next 8 chapters, or 146 pages, on faith. The essential equations in the greatest abundance are there and their meanings explained, but checking them all up would be no easy task.

The general conclusions all this mathematical work leads to are given in a short chapter of only 6 pages, and in another place 20 separate theses are proposed that should set many young men at work on problems that are both new and useful in applied mathematics.

But, the "practical" man will say, what's the use of all this theory and all these mathematical equations? The answer in this case as in all similar cases is: To tell the practical man what to practise, what experiments are needed and what are not, what general type of machine is likely to succeed and what is certain to fail; to save him from needless blundering and to assure him of results and how to obtain them that he never did and never would even dream of.

Professor Bryan's book is especially adapted to the needs of advanced students in physics, applied mathematics and certain branches of engineering, and richly deserves a place in both mathematical and physical libraries.

W. J. HUMPHREYS

Non-Marine Mollusca of Patagonia. By HENRY A. PILSBRY. Reports Princeton University Expeditions to Patagonia, Vol. III., Part V.

This important work was issued in 1911, but there is nothing about the separate issue to indicate the date. It deals with the non-marine molluscs of Tierra del Fuego and Patagonia as far north as the thirty-ninth parallel, and is most beautifully illustrated by colored and uncolored plates. Of certain families, all the South American forms are listed. At the end is given a most interesting discussion of the characteristics and origin of the South American Mollusca.

The poverty of the Patagonian fauna in land snails is remarkable. Seven Endodon-

tidæ and the two Zonitidæ have been described, all small. Their precise affinities are uncertain, from lack of knowledge of the internal anatomy. A small slug has been reported, perhaps introduced. *Succinea* is represented by several species, one of them abundant. No doubt other species will be discovered, but certainly no other part of the world, in a similar latitude, has such a meager representation of land shells. With the fresh-water snails it is somewhat different, the fauna not only containing a number of species of the families familiar in the northern hemisphere, but also a rich representation of the Chiliniidæ, a family confined to the temperate and cold zones of South America. All the Chiliniids east of the Andes are discussed, with four fine plates. Six colored plates are devoted to the Amnicolid genus *Potamolithus*, of which a complete revision is given. There is a complete list of the South American Sphæriidæ, with descriptions of several species. Thus the work, while ostensibly a report on the Princeton collections, is in reality much more extensive and important than the title would suggest.

All zoologists will be interested in the general discussion of the fauna. Dr. Pilsbry recognizes a Cœnogæic or northern group of families, and an Eogæic or southern group, the latter having "occupied chiefly the Gondwana continent, including a large part of South America, tropical and South Africa, and stretching in a great arch, possibly at no time perfect, to peninsular India and Australia." It is in this second group that he would place the Mutelidæ, Ampullariidæ, Acavidæ, Bulimulidæ, Achatinidæ, Strep-taxidæ, etc. With regard to Antarctica, it is shown that the non-marine molluscs, taken by themselves, indicate that: (1) "There is no evidence that Antarctica was ever an evolution or radiation center for non-marine mollusks, though there is some evidence showing that it served as a highway for migration." (2) "There is some evidence of migration from South America to Australia, but at present no evidence of a counter movement to South America." (3) "Nothing in the dis-

tribution of mollusks would lead to the hypothesis that South Africa has ever been connected with Antarctica and thereby indirectly with southern South America." It is finally concluded that "the South American molluscan fauna is traceable to two sources: an ancient southern continent lying across the south Atlantic and enduring from at least Palæozoic to near the end of Cretaceous time, and to Miocene and Pliocene to recent connections with the middle American area." Since the appearance of Dr. Pilsbry's work, Dr. Ortmann has published the anatomy of the Australian fresh-water mussel *Hyridella*, showing that it is indeed allied to the South American *Diplodon*, further suggesting communication between these areas. All these matters no doubt deserve fuller discussion. According to Dr. Schuchert's recent map, North America was rather broadly continuous with South in the late Comanchian period, and remained so during the Cretaceous. During the early and middle Tertiary this connection was interrupted; but with the coming of the Pliocene, according to Dr. H. F. Osborn, it was renewed, and has continued to the present day. There should be, therefore, two elements in the neotropical fauna, both derived from the north, one of Mesozoic age, the other late Tertiary. The latter is recognized by Dr. Pilsbry, but where is the former? Is it not, at least in part, the "Eogæic" group of families? Is there anything in the Molluscan fauna which really supports the idea of a gigantic Gondwana continent, or any other body of land crossing the Atlantic or Pacific? It is true that molluscs are likely to travel slowly, the pace of the snail is proverbial; but they are ancient and have had time enough. *Cochlicopa lubrica*, assuredly a member of a Palæarctic group, has contrived to crawl all the way from the old world to New Mexico within the lifetime of its specific type, the animal being quite the same in Europe as in America. There is surely nothing in the distribution of snails which might not be explained by migrations from the north, and as to the negative evidence based on northern palæontology, it is clearly not worth much. As Dr. Pilsbry truly says, "the rarity of land and

fresh-water shells as fossils, and the great antiquity of the family groups, renders the question very intricate." On the other side, there is the fact that the Chilinidae, certainly of no recent origin, have apparently never left South America. There are reasons for thinking that in Palæozoic times the Antarctic land mass supported a more or less luxuriant flora, with a corresponding fauna, which doubtless eventually spread in part to other regions of the earth.¹ It is even possible that the Chilinidae came from this source; but we can hardly expect to find much, if any, clue to the components of this antarctic biota in the present distribution of life, for the simple reason that there has been abundant time for it to spread over the whole earth, wherever the conditions permitted.

With regard to the northern route from South America to Africa or Australia, or *vice versa*, it should be clearly understood that it is not necessary for a whole fauna to migrate, to account for such faunal resemblances as exist. Thus the Characinid fishes are to-day abundantly represented in the Ethiopian and Neotropical regions, but do not exist elsewhere except that one or two species enter the southwestern part of the nearctic. No fossil Characinids have been found in the north. The naïve conception of a transatlantic bridge on which the Characinids freely traveled appeals to the imagination, but it is found on examination that only one part of the African Characinid fauna is really at all close to the South American, while the latter has very important elements totally diverse from the African series. The indications are that the Characinids arose in the neotropical, and at some very remote period reached Africa, where they developed a type (Ichthyoborinæ + Distichodontinæ, probably to be regarded as a distinct family Distichodontidae) entirely unique in some of its characters. At a much later time the Hydrocyonine Characinids appear to have arrived in Africa, the immigrants consisting perhaps of not more than one or two species, which during a relatively brief period overran the northern hemisphere, leav-

¹ See, for instance, Seward, *Quarterly Journal Geological Society*, August, 1897, pp. 335-338.

ing perhaps no fossil remains which will ever be detected.²

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

SPECIAL ARTICLES

NOTE ON THE UPPER EOCENE TITANOTHERIOD
TELMATHERIUM (?) INCISIVUM DOUG-
LASS FROM THE UINTA BASIN

IN describing the type of this species (a skull, No. 2,398 Carnegie Museum Catalogue of Vertebrate Fossils) Mr. Douglass¹ said:

I think that this skull represents a different genus from *Telmatherium*, but I prefer to place it provisionally here rather than establish another genus.

Through the courtesy of Mr. Douglass, Director Holland and Professor Osborn, the present writer has been enabled to compare this type with the extensive Eocene Titanotheroid material in the American Museum of Natural History. With the approval of these gentlemen the species *Telmatherium* (?) *incisivum* Douglass is hereby made the type of a new genus or subgenus *Sthenodectes*.³ This genus is distinguished from *Telmatherium ultimum* Osborn by the following assemblage of characters: (1) The incisors are far larger and more advanced in evolution, *i*¹ being closely appressed to its fellow in the median line, with anterior face elongate, anterointernal tip blunt, median basin large, posterior wall or cingulum very massive; *i*², *i*³ extremely large with low recurved tips and very heavy posterior cingula. (2) The postcanine diastema is reduced or absent. (3) Superior premolars 2, 3, 4 are much more advanced than in *T. ultimum*, having very heavy internal cingula, pronounced external cingula, high slender internal cusps (deuterocones); *p*¹ especially is in a relatively advanced stage, as compared with *T. ultimum*. (4) The least

² The Cichlidae, with a very similar distribution, have left us beautifully preserved fossils of Eocene age in Wyoming, but not elsewhere.

³ *Ann. Carnegie Mus.*, Vol. VI., No. 2, 1909, p. 305.

² *σθένος*, strength, *δγκητής*, a biter, in allusion to the great power and development of the incisors and canines.

transverse diameters of *p*¹ and of the anterior lobe of *m*¹, are greater, that of *m*³ much less, than in *T. ultimum*. (5) The basicranial region differs in many details, such as the apparent junction of the post-glenoid and post-tympanic processes below the auditory meatus. (6) The occiput is low with a sharp, long, sagittal crest. (7) The forehead is relatively wide. (8) The nasals taper distally.

From *Manteoceras* (especially *M. uintensis*) the genus under consideration is distinguished by: (1) The form and size of the incisors and canines, (2) the much more advanced stage of evolution of the premolars, (3) the shorter anteroposterior diameter of *m*¹, (4) the reduction of the post-canine diastema, (5) the arched and spreading zygomata; etc.

From *Dolichorhinus* and *Mesatirhinus* it is separated by the shortness and relative breadth of the skull, the great size of the incisors, the relatively heavy zygomata and many other details.

The genus or subgenus *Sthenodectes* is apparently allied to *Metarhinus* and may well be related to *Metarhinus earlei* Osborn from the Upper Washakie, which it resembles in important characters of the premolars and molars, form of the basis cranii and occiput, marked constriction of the face in front of the orbits as seen from above. The narrow tapering nasals and other characters also suggest affinity with *Metarhinus diploconus*. The type skull of *Sthenodectes incisivum* differs from all known *Metarhinus* material in the form and in the very large size of the incisors and canines, in the much stronger internal cingula on the premolars, stout zygomata, junction of the post-glenoid and post-tympanic processes below the auditory meatus. The forms of the premaxillary and of the subnasal incisures also differ from those of *Metarhinus*. The supposed vacuities in the lachrymal region, although indicated on both sides, may be artifact.

WILLIAM K. GREGORY

OIL CONCENTRATION ABOUT SALT DOMES

IN several national, state and private publications the writer has called attention to the remarkable concretionary growth and bodily

movement upwards of huge masses of rock salt in Cenozoic deposits along the Gulf border. The bearing of the structures produced in the neighboring beds by such growths and movements on oil concentration was duly set forth in Bulletin 429 of the United States Geological Survey. Recently he has had the opportunity of testing the value of his "dome theory" for locating oil "pools" in a region far away from any known oil occurrences. Reference is here made to Pine Prairie, south central Louisiana, where the Myles Mineral Co. has had the courage to try out the theory and has discovered by the means a new oil field. The director writes "I consider this a most remarkable vindication of a theory originated by you, and we attribute a large measure of our success thus far to your advice."

Space should not be taken here to discuss the probable exact location of oil in connection with these domes; that is a matter depending largely on the approach of the salt dome to the surface, size, location, etc. These matters have been outlined at least in the U. S. Geological Survey Bulletin already referred to. But the location of oil by means of a theory unheard of ten years ago does seem worthy of record at this time. Another fact that should be impressed upon the mind of the public now is the absolute worthlessness of stock in companies putting down wells "near" the discovery well. This matter has, however, been discussed in Bulletin 429.

G. D. HARRIS

CORNELL UNIVERSITY

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE
SECTION D

DR. J. A. HOLMES, director of the Bureau of Mines, was elected vice-president of the association and chairman of Section D for the next meeting, at Cleveland. Professor O. P. Hood was elected a member of the council for the Cleveland meeting and Major W. W. Crosby a member of the sectional committee for five years, *vice* Professor J. E. Boyd, whose term expired. Mr. W. Bowie represented the section in the general committee.

The meetings of the section were presided over by Vice-president C. S. Howe, of Cleveland. The section held its first session on Wednesday morning, December 27, at Georgetown Law School. Two sessions were held on Thursday at the same place. On Friday morning and afternoon the section met in the Institute for Industrial Research. On Saturday, visits of inspection, under the direction of Professor A. H. Blanchard, were made to the office of good roads and to the sites of actual road construction in the vicinity of Washington and Baltimore.

On Thursday afternoon, following the address of retiring Vice-president A. L. Rotch, the following resolutions were adopted:

WHEREAS, the new and important art of navigating the air requires for its proper development exclusive investigations in aerodynamics, and thorough comparative tests of practical aerial machines, and

WHEREAS, the Aero Club of America proposes to secure the endowment of a laboratory for such investigations and comparative tests, therefore be it

Resolved, That the Engineering Section of the American Association for the Advancement of Science expresses to the Aero Club of America its appreciation of the urgent need for such a laboratory, and heartily commends its efforts to secure an adequate endowment, and be it further

Resolved, That a copy of these resolutions be sent to the Aero Club of America, with best wishes for the success of its efforts.

On Friday afternoon, resolutions were adopted extending the thanks and appreciation of the section to Dr. A. S. Cushman, director of the Institute for Industrial Research, for the use of the laboratory for the meetings on that day. The secretary takes this occasion to express his appreciation of the valuable assistance of Dr. C. S. Howe and Professor A. H. Blanchard in securing papers for the program and to the members and non-members who contributed.

The Washington meeting of Section D was successful beyond expectations, the papers being valuable and interesting and the attendance at the sessions encouraging as to numbers and interest manifested.

Abstracts and titles are listed below by groups.

MISCELLANEOUS PAPERS AND TITLES

Analysis of the Deflections and Stresses in Reinforced Concrete Floor Slabs Constructed on

the Turner Mushroom System: H. T. EDDY, University of Minnesota.

Owing to the apparently irregular distribution of the reinforcement employed in this system and to the uncertainty as to the value of Poisson's ratio or lateral contraction for reinforced concrete, engineers have differed widely in their estimates of the strength and stiffness of this form of construction, and have distrusted the results of tests made to determine deflections. The author has in this paper given a complete rational analysis of this form of construction and derived simplified but closely approximate practical formulæ for the resistance and deflection of this slab, showing how the various constants depend upon the properties of the materials composing the slab and how their arrangement affects its strength and rigidity. Of these several constants Poisson's ratio is the most important. It is shown in the paper that the value of Poisson's ratio obtained from experiments upon ordinary test specimens of square or round cross section is necessarily much too small for material circumstances as is the reinforcement in a slab. The experimental results obtained from the deflection of mushroom slabs makes it probable that the proper value of Poisson's ratio for the reinforcement is nearly twice that obtained from ordinary test specimens. On this basis the theoretical results arrived at in the paper agree in a very striking and remarkable manner with the empirical formulæ which have been proposed to express the results of the numerous tests heretofore made on such slabs.

The Primary Triangulation System of the United States; its Extent and Uses: WILLIAM BOWIE, U. S. Coast and Geodetic Survey.

This paper shows that extended areas can not be accurately controlled by a number of disconnected local trigonometric surveys, owing to the deflection of the vertical (or the station error) at the astronomic stations which control the positions of the several schemes of triangulation. The primary triangulation, on the other hand, is continuous and no discrepancies will be shown between detailed surveys based upon it. The positions of objects shown on maps, charts and surveys based on the U. S. Standard datum will probably never be changed. Examples are cited of the use of trigonometric surveys by the United States and Canada Boundary Survey, by the state of Maryland in its oyster survey, by the Isthmian Canal Commission, by the city of New York and by the

Clinchfield Coal Corporation in Tennessee. It is planned to extend the primary triangulation into new areas as readily as possible, and it is hoped that, eventually, no place in the United States will be more than 150 miles from some primary station.

Curved Line Vernier Method: H. E. WETHERILL, Philadelphia. Read by title.

Differentiation of Saturated Vapor Engines: J. E. SIEBEL, Chicago. Read by title.

PAPERS ON THE WORK OF THE BUREAU OF MINES
In Relation to Gas Producers and Internal Combustion Engines: R. H. FERNALD, Case School of Applied Science.

The investigations show that practically every shipment of fuel tested in the gas producers, including coals as high as 44 per cent. ash, and lignites and peats high in moisture, has been successfully converted into producer gas which has been used in operating gas engines. It has been estimated that on an average there was developed from each coal tested in the gas producer plant two and a half times the power developed when used in the ordinary steam-boiler plant, and that such relative efficiencies will probably hold good for the average plant of moderate power capacity, though this ratio may be reduced in large steam plants of the most modern type. It was found that the low-grade lignite of North Dakota developed as much power when converted into producer gas as did the best West Virginia bituminous coals when utilized under the steam boiler; and in this way lignite beds underlying from 20,000,000 to 30,000,000 acres of public lands, supposed to have little or no commercial value, through these investigations have been shown to have a large value for power development and the money value of the government's own property has been increased to the extent of probably \$300,000,000 or more. The investigations into the waste of coal in mining have shown the enormous extent of this waste, aggregating from probably 200,000,000 to 300,000,000 tons yearly, of which at least one half might be saved. It is being demonstrated that the low-grade coals high in sulphur and ash now being left underground can be used economically in the gas producer for power and light and should, therefore, be mined at the same time that the high-grade coal is being removed. The use of these low-grade fuels, which have previously been regarded as of little or no value, increases our fuel resources approximately (on the basis of present marketable grades): low-grade bituminous and anthracite, 75-100 per cent.; sub-bituminous, lig-

nite and peat, 60 per cent; or roughly, total increase of 150 per cent. over our present supply of marketable grades of fuel. The logical conclusion from a careful study of the producer gas power situation is that the time is not distant when financial interests in power production will be directed toward the centralization of the producer-gas power plant at the mines and the distribution of the energy developed either by high-voltage long-distance electrical transmission or by pipe systems for conveying the gas.

Investigations in Relation to Fuels and Fuel Efficiencies: O. P. HOOD and S. B. FLAGG, Bureau of Mines.

The Bureau of Mines is engaged in investigating the general problem of the conservation of our mineral fuels by careful study of the problems of preventing waste in mining transportation and storage and of increasing the efficiency with which the fuel is finally used for heat, power, etc., and also the problem of utilization of inferior fuels not now generally used, owing to ignorance as to their value and the means of making that value available. The study of the problem of combustion for steam and for gas engines was inaugurated on a large scale in 1904, and is still in progress. At present the combustion of fuel for steam purposes is being examined in a specially constructed furnace permitting of the determination of temperatures and chemical composition at short intervals between the fire and the stack, and the values of refuse collecting at mines and in yards, and of lignite, peat and miscellaneous wastes from various industries, as fuels for the producer gas engine are being carefully investigated. Also the advantages of briquetting for rapidly deteriorating fuels, the best methods of transportation and storage, the prevention of mine explosions, spontaneous combustion and smoke are receiving careful attention. The purchase of fuel on the basis of specifications covering heat value and composition with penalty and premium provisions has been materially advanced by the bureau. The investigations of the bureau have been favorably received and the results in application by fuel producers and users have been gratifying and encouraging to further work.

With Special Relation to Safety in Mining, Quarrying and Metallurgical Operations: J. A. HOLMES, Director, Bureau of Mines.

The main purpose of the bureau is to increase health and safety in the mineral industries. It is endeavoring to collect statistics relating to acci-

dents and health conditions in and about mines, quarries and metallurgical plants, and is investigating the causes of accidents and the conditions inimical to health and safety. One of the most important investigations is that of the cause of mine explosions, which involves a study of mine gases and coal dust and the conditions under which inflammable gases and dusts may be ignited. A related investigation, that of explosives used in coal mining, was undertaken to determine what explosives are least likely to ignite gases or coal dust. Another investigation deals with the prevention of accidents from electrical equipment in mines. The miscellaneous accidents in mines, including falls of roof, are also being investigated. These miscellaneous accidents, though individually small, each year kill more miners than the great explosions. The mine-rescue and first-aid work of the bureau has attracted more attention than its investigations. The bureau now has six mine-rescue stations and seven mine-rescue or mine-safety cars in the more important coal fields of the country. The work of these stations and cars is largely educational, training miners in mine-rescue and first-aid methods and demonstrating equipment and appliances. More cars and more equipment are needed. It is expected that within a few years the bureau will have trained 20,000 miners, who will be organized into local mine-rescue and first-aid corps, to be supported without aid from the federal government. The success of the bureau's work in behalf of safety will depend on how far this work receives the cooperation of mine owners and miners. The federal government can conduct investigations, the states can embody the results of these investigations in laws, but the cooperation of mine owner and miner are essential to success. The progress in lessening accidents is slow and there is serious need for extending the work of the bureau. Its investigations hitherto largely confined to the health and safety problems about coal mines, should cover similar problems at metal mines, quarries and metallurgical plants.

PAPERS ON AERONAUTICS AND AERIAL ENGINEERING

Holes in the Air: W. J. HUMPHREYS, U. S. Weather Bureau.

Aeronauts have adopted the picturesque phrase, "holes in the air," to describe that condition of the atmosphere that makes uniform horizontal flight impossible, and causes great danger to the aviator. Among the atmospheric conditions that may cause a greater or less drop of the aeroplane

are (a) horizontal strata moving with different velocities, (b) columns of air with different vertical components. The boundary between such strata and columns often is quite narrow, and hence the aviator may pass with disconcerting abruptness from one to the other. On certain conditions the downward acceleration may be even in excess of that due to gravitation and thus the aviator thrown out of his seat.

Aeronautical Screw Propellers: SPENCER HEATH, Washington.

The author discussed the propeller as a transmitter of power, the losses of efficiency due to slip and skin friction. He explained the design of the propeller on the principle that each section is an aerofoil traversing a helical path and deduced the formulae for slip, pitch, thrust, speed and lost power, with applications to two specific cases. The paper was illustrated with numerous diagrams and full-size propeller blades.

Revolving Cylinder Aerial Motor: EMIL BERLINER, Washington.

Under this title, the speaker described the principle of design and construction of a new type of gasoline engine for propelling aircraft. This is made in two sizes and so designed and built as to give considerable power and good running balance.

Work of the Signal Corps in Aeronautics: G. O. SQUIER, Signal Corps, U. S. A.

The speaker gave a description of the work which has been done by the signal corps of the U. S. Army in the study of the prospects of the aeroplane for reconnaissance and dispatch work. A training school for members of the signal corps is established and a number of recruits are enrolled.

Endowment, Organization and Equipment of Aerodynamic Laboratories: A. F. ZAHM, Washington.

Definition, functions, scope of aeronautic and aerodynamic laboratories. Bearing on the development of aeronautic science, art and industry. Endowment, organization and equipment of the Institut Aerodynamique de Koutchino, of the Aerodynamical Laboratory of the University of Göttingen, the Institut Perotechnique de St. Cyr, Eiffel's Aerodynamic Laboratory, etc. Methods of experimentation and results obtained in various laboratories. Aero Club of America's movement to secure the endowment of a national aeronautic laboratory.

Aerial Engineering: A. LAWRENCE ROTCH, Blue Hill Observatory.

Vice-presidential address, published *verbatim* in SCIENCE, January 12, 1912.

PAPERS ON ROAD AND HIGHWAY ENGINEERING

History of Washington Bituminous Concrete Pavements: MARTIN BROOKE, Washington.

Bituminous concrete pavement was first laid in Washington in 1871, since which date over a million square yards have been laid. Eight hundred thousand square yards are still in existence, less than two hundred thousand yards of which are in the original form. Between 1871 and 1878 half a dozen different types of patented bituminous concrete pavements were laid, a considerable portion of which were unsatisfactory and required resurfacing within a few years. The best of them, however, were fairly durable and economical, and some have continued in use to this day. These pavements were characterized by their thickness and density and by the quality and amount of the tar and tar-asphalt binder used. Bituminous concrete was abandoned in 1878 for sheet asphalt on hydraulic cement base, until 1888, when the inability to obtain bids for the latter type within the legal limit of two dollars per square yard set by Congress compelled the reintroduction of bituminous concrete. The pavements of this character laid between 1888 and 1893 under District of Columbia specifications were cheaper pavements than the old type, and the tar distillate binder used was decidedly inferior to the old tar. Since 1909, a bituminous macadam has been laid in suburban streets, which is very similar to the bituminous concrete pavement laid in the seventies.

History of Tar Concrete Pavements in Ontario:

W. A. McLEAN, Toronto.

The first tar-concrete pavement in Ontario (Canada) was laid in Hamilton in 1880, a part of which is still in use. During the years 1889-1906 numerous tar-macadam pavements were laid in seven cities of the province, aggregating about 25 miles. Except in the city of Guelph, the use of commercial coal tar has been displaced by refined tar or other proprietary bitumens. The general experience was that for the first three years the surface has been satisfactory; in five years the surface coat, if not renewed, was worn away in spots; at the end of ten years the surface was generally rough and disintegrated, but still protected the foundation. In Hamilton and Toronto the tar macadam after five or ten years has been protected by a wearing surface of sheet asphalt, from one to two inches in thickness. Experience has indicated that tar of uniform quality and of composition within certain range of proportions, while susceptible to extremes of temperature, is not debarred by climatic or other conditions, as

a useful road material; that best results require a dense mixture, preferably proportioning the aggregate for maximum density; that some doubt may be attached to the complete durability of bituminous surfaces made by the penetration process, and suggesting that the grading of stone in this method, rather than having a uniform size, is desirable; that a moderately coarse aggregate should be brought to the surface, to overcome slipperiness and take up wear; that tar-concrete is less durable under concentrated wear than is sheet asphalt; that broken stone will provide a more stable structure than will water-rounded gravel when bonded by tar; that a paint and grit coat is necessary as a preservative as frequently as signs of surface wear or oxidation appear.

Surface Treatment of Park Roads: SPENCER CROSBY, Washington.

In building and rebuilding park roads in Washington in the last few years a heavy oil or tar binder, applied by the penetration method, has been used with most satisfactory results. For the surface treatment of existing macadam roads, emulsions, waste sulphite liquors, coal gas and water gas tars, and asphaltic oils have been experimented with and last have been found to give best results. One application per year is sufficient to keep the surface in excellent condition. During the last fiscal year 166,000 square yards of park roads were given surface application of oil or tar at an average cost of 2½ cents per square yard, not including cost of screenings. This compares with an average cost of 3.2 cents per square yard for watering in previous years.

Oyster Shell Roads: W. W. CROSBY, Johns Hopkins University.

General remarks on arguments for and limits to use of shells for road purposes. Descriptions of results in Maryland. Particular points to be observed in construction and specifications recommended. Use of bituminous material in connection with shells. Costs of construction and of treatment with bitumen. (Six photographs showing shell roads treated and untreated.)

Changes in Pitch under Exposure and Traffic: W. W. CROSBY.

Description of construction and analysis of tar used. Description of traffic conditions and record of traffic census. Description of results apparent. Analysis of tar surface after three years of use and of tar extracted from samples of this surface. Conclusions as to changes in tar that have apparently occurred.

The Chemistry of Modern Highway Engineering: PREVOST HUBBARD, Institute for Industrial Research.

The necessity of chemical training for modern highway engineers is discussed at some length, and an outline is given of what the author believes to be the essentials of such training. Columbia University has already made the chemistry of road materials a part of its new post-graduate course in highway engineering. It is believed that this training will establish closer relations between the highway engineer and the chemist. Modern conditions demand the work of specialists in highway construction as in many other branches of engineering, and it is not reasonable to expect that the man whose training has been primarily developed along engineering lines can satisfactorily apply the principles of other highly specialized subjects to his work without the assistance of those who have specialized in such subjects. Therefore, the highway engineer should not attempt the chemical testing of road materials, but should cooperate with the chemist in this matter.

A Review of the Use of Bituminous Materials in the Construction and Maintenance of American Highways during 1911: A. H. BLANCHARD, Columbia University.

The following table shows the characteristic developments in the use of bituminous materials during the years 1908, 1909, 1910 and 1911 under the supervision of the highway departments of Maine, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania and Maryland. The quantities are square yards.

SURFACE TREATMENT OF ROADS

Tars and Tar-Asphalt Compounds	Fluxed Native Asphalts Oil Asphalts and Residual Asphaltic and Semi-asphaltic Oils	Light Oils
1908. 57,700	1908. 239,500	1908.
1909. 95,500	1909. 910,600	1909. 4,125,900
1910. 123,400	1910. 2,434,200	1910. 9,890,400
1911. 433,000	1911. 7,980,000	1911. 3,765,000

BITUMINOUS PAVEMENTS CONSTRUCTED BY PENETRATION METHODS

Tars and Tar-Asphalt Compounds	Fluxed Native Asphalts Oil Asphalts and Residual Asphaltic and Semi-asphaltic Oils	Light Oils
1908. . 37,800	1908. . 25,200	1908.
1909. .170,200	1909. .2,077,400	1909.
1910. .339,300	1910. .4,840,200	1910. .26,500
1911. .122,000	1911. .8,600,000	1911.

BITUMINOUS PAVEMENTS CONSTRUCTED BY
MIXING METHODS

Tars and Tar-Asphalt Compounds	Fluxed Native Asphalts Oil Asphalts and Residual Asphaltic and Semi-asphaltic Oils	Light Oils
1908.. 52,100	1908.. 4,400	1908.....
1909.. 136,000	1909.. 219,500	1909.....
1910.. 158,000	1910.. 432,600	1910.....
1911.. 24,350	1911.. 508,100	1911.....

The most important developments during 1911 were as follows: the increased use of the mixing method of constructing bituminous concrete pavements due to the introduction of economical and efficient mixing plants and less fear of injunction and law suits brought by patentees; the manufacture of many types of gravity and pressure distributors for use in the construction and maintenance of bituminous surfaces and bituminous pavements built by penetration methods; the demand by many engineers for bituminous materials for bituminous surfaces which will set up in from 24 to 48 hours; increase in recording scientific data such as recommended by the special committee on the Use of Bituminous Materials of the American Society of Civil Engineers.

Organization of a Highways Maintenance Bureau of a Municipality: W. H. CONNELL, New York City.

It is, in the writer's opinion, desirable in the organization of a Highways-Maintenance Bureau to follow the theory of centralization of control. First comes the planning of an organization adapted to the needs of the municipality, then the proper control of the same, which can only be accomplished through the appointment of men especially qualified to supervise the work of the various branches of the organization. The responsibility of course should be centered in one man, and he should be familiar with the social conditions of the municipality and keep in close touch with the activities of the divisions under his control. All work should be initiated through job orders and unit cost records kept of the same. All street repairs, etc., should be done by the highways-maintenance force. All repairs to pavements between railway tracks over corporation cuts, etc., should be done through and under the supervision of the Highways-Maintenance Bureau. This procedure centralizes the responsibility and control of work coming under the jurisdiction of said bureau.

Utilization of Motor Truck Trains in the Maintenance of Truck Highways: L. W. PAGE, Office of Public Roads.

The object to be accomplished is the development of an automobile equipment which will include all the apparatus and facilities necessary to efficiently employ a repair gang of eight men in the maintenance of road surface over one hundred miles of roadway or more as the working conditions will permit. This purpose as set forth has three significant implications: First, that the cost of the equipment should be kept consistently low or within the range of customary expenditures in this direction; second, novel or especially manufactured apparatus should be avoided so that the equivalent apparatus can be secured in any locality, and, further, that existing investment in similar details of equipment can be made use of; third, that the outfit should be so flexible in its makeup as to readily serve a variety of utility or lend itself to peculiar requirements under varying conditions. In performing service in road repairing, the machine should incorporate as many of the requirements of a portable power plant as possible, such as hoisting, pumping, and, where necessary, air compression and power-shaft driving. The automobile chassis selected for recommendation is the 5-ton gas-electric type manufactured by the Couple-Gear Freight Wheel Company, Grand Rapids, Michigan. This chassis is fitted with a Sprague electric hoist, which can be used for a variety of purposes. The motor of this hoist is directly connected to a rotary pump which can be used to furnish bituminous material from a tank carried on the machine through a distributing device permanently attached to the rear of the chassis. An electric air compressor and a power sweeper could also be attached to the machine. The chassis can be fitted with a removable platform body, with or without stakes or side racks; and it may also be fitted with a steel dumping body, the forward half of this body to be fitted with removable partitions to provide spaces of one or two cubic yards capacity for carrying different sizes of road material. The rear half of the body may be used for carrying the bituminous heating tank. Seats for four men and spaces for tools are provided between the dumping body and the driver's seat. The latter is made wide enough to carry three men beside the driver. It would be impossible to use standard wagons as trailers for carrying material, and a sprinkling wagon or bituminous tank mounted on its own wheels could also be carried behind the tractor. It would prob-

ably be necessary to establish supply stations at intervals along the road to be maintained with this equipment.

Underground Pipe Construction in Streets: C. E.

BOLLING, Richmond, Va.

Much money could be saved in street construction and maintenance if pipe systems, such as for water, gas, sewer, etc., were laid before the surface of the roadway was constructed. All main pipes should be placed and connecting pipes laid to each lot, whether the latter are occupied or vacant. The estimated annual cost on such connections, assuming a 4 per cent. interest on the outlay, is 96 cents. The rapid rate of growth of communities so improved is marked. The increased value of abutting property, due to the conveniences obtained, creates tax receipts generally in excess of this annual interest. The cost of making pipe connections through improved roadways is at least 60 per cent. greater than through unimproved ones, and the cost of restoring and maintaining the pavement is doubled.

Impact Testing Machine for Pitch: W. H. FULWEILER, Philadelphia.

This apparatus was designed to determine the relative binding qualities of bituminous materials used in road construction and maintenance. The material to be tested is enclosed as a thin film between two steel dies. The dies are designed to avoid the effect of suction. An excessive breaking load is applied by the impact of a falling weight, and the resistance to rupture of the film is recorded by a spring balance provided with a maximum indication hand. This form of apparatus may be used to compare the binding qualities of any grade of material. In a modification of this apparatus a pendulum in falling separates the dies, and automatically records the energy absorbed. The results obtained have not yet been completely analyzed, but apparently they will serve to differentiate classes of materials and indicate the most effective viscosity of any material for road use.

Centrifugal Method for the Determination of Free Carbon: W. H. FULWEILER.

This method was designed to afford rapid and reasonably accurate results to obviate the danger of handling carbon bisulphide in the laboratory. The material is weighed with a stoppered Goetz phosphorus tube dissolved in CS₂ with shaking and centrifuged until the precipitate ceases to contract. The percentage may then be read off directly. The tubes are calibrated for the particular class of material to be tested by reference to standard

samples. Care must be taken to keep the tubes scrupulously clean. The lower the percentage of free carbon the closer this method checks with the ordinary gravimetric method. In this method the carbon bisulphide is not exposed to the air and considerably smaller quantities are required.

Cost of Road Building with Convict Labor: J. H.

PRATT, Chapel Hill, N. C.

The author has not submitted abstract.

The following papers in this group were read by title in the absence of authors and manuscripts:

Street Asphalt Paving Mixtures, and Value of Blown Asphalts and their Manipulation: H. B. PULLAR, Chicago.

Organization of the Engineering Department of Coleman du Pont Road, Inc.: F. M. WILLIAMS, Delaware.

Organization of Convict Labor on the Virginia State Highways: P. ST. J. WILSON, Richmond, Va.

Some Limitations of Distributing Machines: H. B. DROWNE, Columbia University

Voids in the Aggregates of Bituminous Concrete Pavements: A. H. BLANCHARD, E. R. DONLE and C. M. HATHAWAY, Columbia University.

It is expected that the papers of this group will be published in book form at an early date.

G. W. BISSELL,

Secretary

SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The seventh regular meeting of the society was held at Dr. Ransom's residence on December 19, 1911, Dr. Ransom acting as host and Mr. Crawley as chairman.

Dr. Pfender presented a brief note on the desirability of zoologists and medical men using *Treponema* rather than *Spirochata* for the organism causing syphilis.

Mr. Foster presented the following note:

Analysis of the Results of 87 Fecal Examinations of Sheep Dogs for Evidences of Parasitism.

Order No. 176 of the Bureau of Animal Industry requires that all collie or sheep dogs imported to this country shall be held in quarantine pending the result of a fecal examination to determine the presence or absence of the gid tapeworm. As it is difficult to distinguish the eggs of the gid tapeworm from those of other less injurious species, all dogs found infested with tapeworms are given a suitable tæniacide.

Since November 25, 1910, when this order went

into effect, the feces of 87 dogs have been examined. Of these, 50 dogs, or about 57 per cent., were infested with parasitic worms. Of the 50 dogs thus parasitized, 28 were infested with nematodes only, while 22, or about one fourth of the dogs examined, were infested with tapeworms, either of one species only, of two or more species, or of tapeworms and nematodes.

Of the 22 dogs infested with tapeworms, there were

- 7 infestations with *Tænia hydatigena*,
- 8 infestations with *Tænia pisiformis*,
- 4 infestations with *Dipylidium caninum*,
- 2 infestations with *Multiceps serialis*,
- 8 infestations with unidentified *Tænia*.

This is a total of 29 infestations with tapeworms, representing four recognized species. The number of infestations is of course greater than the number of dogs infested, since in several cases one dog proved to be the host of two or more species.

The heaviest infestation recorded, from 14 to 19 specimens of tapeworms, representing three species, was as follows:

	Specimens
<i>Tænia hydatigena</i>	6
<i>Tænia pisiformis</i>	3
<i>Dipylidium caninum</i>	5-10

It will be seen from the foregoing that *T. hydatigena* is the tapeworm which was most frequently found. Out of 37 identified specimens, this species occurred 13 times, 35 per cent. of the specimens identified being of this species. *D. caninum*, although found in but 4 infestations, comes next in number of specimens found, *i. e.*, 12. There were 8 infestations with *T. pisiformis*, with a total of 10 specimens, while only 2 specimens of *M. serialis* were found and in both cases the identification is uncertain.

Of the 87 dogs examined,

- 9.2% were infested with unidentified tapeworms,
- 9.2% were infested with *Tænia pisiformis*,
- 8.1% were infested with *Tænia hydatigena*,
- 4.5% were infested with *Dipylidium caninum*,
- 2.3% were infested with *Multiceps serialis*.

It is interesting to note what a small per cent. were infested with *D. caninum*, which is usually considered the commonest dog tapeworm. In all the species considered in this paper, the percentage of infestation is far lower than the average given in the comparative table of Stiles, 1898 ("Inspection of Meat for Animal Parasites," p. 105). The writer is inclined to think that the small percentage shown in the examination of imported dogs

is the result of the greater care bestowed on valuable animals such as these are.

Mr. Leonard read a paper entitled "Some Abstracts from Investigations on Parasitic Diseases Carried on at the Marine Hospital, Wilmington, N. C." The paper showed the percentage of infection of man with various intestinal parasites as determined by 688 microscopic examinations.

Mr. Hall presented the following note:

Notes on the Parasite Fauna of Colorado.

The writer has recently compiled a list of the parasites of animals in the state of Colorado, the list covering published records, material in the collections of the Bureau of Animal Industry, the National Museum, the Hygienic Laboratory, the Naval Medical School, and some records furnished by workers in various colleges. Most of the Bureau of Animal Industry specimens from Colorado were collected by the writer during the past summer.

Using the word *identified* to indicate at least a generic identification, the list includes at present a total of 251 identified and 27 unidentified species of protozoan, trematode, cestode, nematode, crustacean, mallophagan, hemipterous, dipterous, siphonapteran, arachnid and annelid parasites.

Among the interesting and apparently new species collected by the writer during 1911 may be mentioned a *Rictularia* and a *Tænia* resembling *T. pisiformis* from *Canis nebracensis*, and a *Chabertia* from *Thomomys fessor*.

One case of hookworms found by Dr. Webb, of Colorado Springs, in a patient from the south is of interest in that it suggests that with carriers of hookworms entering the state, the disease is likely to get a foothold, especially in southern Colorado. In fact, it is likely that an examination of the Mexican miners in southern Colorado, where the climate and the mode of life in the Mexican section of some mining towns is favorable to hookworm development, would be repaid by positive findings.

The collection of a species of *Anopheles* by G. P. Weldon in Delta County is of interest, as this is the first record of this genus from Colorado, according to Professor Gillette, who furnished the writer with the record. In his opinion, we have here the explanation of an outbreak of malaria on the western slope of Colorado.

The occurrence of what Stiles calls *Dermacentor andersoni* and Banks calls *D. venustus* has been reported from ten counties in Colorado by Hunter and Bishopp (1911). It was first reported from Colorado by Banks (1895), under the name of

Dermacentor americanus. As the carrier of Rocky Mountain spotted fever, this tick is of especial interest at present.

Dr. Ransom presented some figures illustrating the life history of *Haemonema muscae* and showing stages in the fly and in the horse. A note on this life history has already been published in *SCIENCE*.

Dr. Ransom presented the following note:

The Occurrence of Cheilospirocha hamulosa in the United States.

The nematode *Cheilospirocha hamulosa* is parasitic in the gizzard of the chicken. A record of the occurrence of this species in the United States has apparently not been published heretofore. The helminthological collection of the Bureau of Animal Industry contains specimens collected in Kansas in 1897, identified by Stiles and Hassall; in New Jersey in 1903, identified by Ransom; in Hawaii in 1907, identified by Hall and Hassall; in the District of Columbia in 1908 and 1909, identified by Hall; in Ohio in 1911, identified by Graybill, and in Indiana in 1911, identified by Ransom.

Dr. Pfender presented the following note:

Symptoms Accompanying an Infection with Tania saginata.

Recently one of the writer's patients, a woman 54 years old, presented herself for treatment and complained of the following symptoms: itching all over the body, skin eruptions, recent trouble with cold feet, twitching of lower limbs, nausea, no desire for food, excessive bloating, flatus, occasional dizziness and excessive leucorrhea. She complained that pieces of worm, from 3 to 30 at a time, were being constantly passed. On treatment with oleoresin of male fern the worm was passed. Since then the nervous and digestive symptoms have entirely disappeared and the general health is improving.

The eighth regular meeting of the society was held in the rooms of the Zoology Division of the Marine Hospital Service, January 11, 1912, Dr. Stiles acting as host and Mr. Foster as chairman.

Dr. Garrison exhibited a specimen of pancreas sent in by Assistant Surgeon Kerr, U.S.N., from Guam. The pancreas had a specimen of *Ascaris lumbricoides* in the duct of Wirsung, extending from the intestinal termination of the duct clear across the pancreas, the head being near the periphery. He also showed two appendices, containing 2 and 3 specimens of the same worm, sent in by Dr. Kerr from the same place.

Dr. Ransom presented pictures of a worm sent

in by Dr. Darling from the Canal Zone and said to have been collected from the urine of man. The worm is a specimen of *Mononchus*, a free-living genus, and the case is therefore one of pseudo-parasitism. The tooth in the buccal capsule would suggest a true parasite to most observers.

Dr. Ransom noted that numerous cases of *Cysticercus bovis* had recently been detected in abattoir inspection, 15 cases having been found in two days at Omaha. The parasite has also been rather common at Chicago, Kansas City, Milwaukee, Buffalo, etc. Up to a year ago, more specimens of *Cysticercus cellulosæ* had been found than of *C. bovis*, due probably to the fact that the former were more carefully looked for.

Dr. Stiles noted that Dr. Francis had recently sent him several cases of *C. cellulosæ* from Texas with the statement that this parasite was not uncommon in Texas.

Dr. Stiles presented a note on the preliminary survey of Texas for hookworm. He spent one month there, working at the state university, the normal school and the schools for the blind and the deaf and dumb, and in the open country. He demonstrated hookworm by microscopic findings in 45 counties and saw undoubted physical cases in another county. The disease occurs chiefly in the eastern portion of the state, and is probably unimportant in the northwest portion. In the rural eastern part, some places show about one third of the people infected. There are some severe cases, but none as bad as the worst cases in Alabama and Mississippi. A preliminary survey of the coal-mining part of West Virginia was interrupted after the hookworm had been microscopically determined in nine localities.

The rest of the evening was devoted to a talk by Dr. Stiles on "Foreign Parasitologists and Their Work."

THE ninth regular meeting of the society was held in the rooms of the Zoology Division of the Marine Hospital Service, 25th and E Streets, N.W., February 16, 1912, the president, Dr. Stiles, acting as host and chairman.

Dr. Stiles presented a number of generic names of parasites of man for consideration by the society. The society agreed to recommend to the International Committee on Nomenclature and to the Committee on Medical Zoology for adoption according to the plan agreed upon at the last Zoological Convention at Gratz, the following names:

Cestoda: *Davainea*, *Diplogonoporus*, *Dipylidium*, *Echinococcus*, *Tenia*.

Nematoda: *Ancylostoma*, *Ascaris*, *Dracunculus*, *Gnathostoma*, *Necator*, *Strongyloides*, *Trichostrongylus*.

Acanthocephala: *Gigantorhynchus*.

Gordiacea: *Gordius*, *Paragordius*.

Dr. Stiles presented a report on the work of the Rockefeller Hookworm Commission, and in this connection noted the compilation of the nomenclature used throughout the world in connection with hookworm disease. He also noted that the name *Necator africanus* given by Looss to a hookworm from the chimpanzee was preoccupied and that he had written to Looss asking him to change it.

Dr. Stiles also presented the outline of a symposium on amebiasis, which is to be part of the program at the coming International Congress of Hygiene and Demography.

Mr. Hall presented the following note:

A Second Case of Multiceps multiceps in the Coyote.

At the meeting of the society in April, 1911, the writer presented a note on a case of *Multiceps multiceps* in the coyote, *Canis nebracensis*. This was a case of infection by artificial feeding with *cœnurus*, the coyote dying six days later of septicæmia. Fifty-two heads of *M. multiceps* were recovered from the intestine. I wish to record a similar case from a coyote in the same litter, fed at the same time. Death occurred 14 days after feeding, and in the writer's absence the post-mortem was made by Dr. Graybill, who found 4 heads of *M. multiceps* in the intestine. A comparison of these heads with the 52 recovered from the first coyote shows that apparently they had not developed any more in 14 days than in 6 days. In this connection may be mentioned a note presented before the society at the meeting in January, 1911, in which a case was noted where a dog fed *cœnurus* 82 days previously was found on post-mortem to have 5 tapeworms, the largest having eggs with undeveloped oncospheres and the smallest being less than one half inch in length.

These data indicate that this worm may at times develop very slowly. Leuckart (1886) has noted that of three dogs fed *cœnurus*, one was found to have over 100 completely developed tapeworms in about ten days; another had only heads of tapeworms after three weeks, with bands of segments an inch long attached to them in a few cases only, while the third failed to develop any tapeworms.

The remainder of the evening was devoted to a

discussion of the nomenclature of parasitic diseases.

MAURICE C. HALL,
Secretary

THE ACADEMY OF SCIENCE OF ST. LOUIS

The meeting of the Academy of Science of St. Louis was held at the Academy Building, Monday, February 19, 1912, at 8 P.M., President Engler in the chair.

Dr. Charles H. Turner presented a paper on "Experimental Study of Color Vision and Pattern Vision of Bees." The conclusion reached by experiments was that bees can distinguish, not only between colors, but also between color-patterns, and that this behavior is of value to them in recognizing plants that contain an abundant supply of honey. Hence, since bees can distinguish colors and the fine details of color-pattern, there is nothing about the visual powers of bees that militates against the theory that the colors and the color-patterns of flowers are adaptations to insect visitors. The bees respond to these colors, not because they prefer one color to another; but, because, under certain conditions the color or color-pattern selected has acquired a utilitarian meaning—has come to be the sign of something worth a response.

Although Plateau's conclusions do not harmonize with the above statement, yet the actual facts observed by him are in perfect accord.

Dr. H. M. Wepley spoke on "Miniature Indian Baskets" and exhibited two specimens made by the Pomo Indians which were viewed by means of simple microscopes. The foundation of the baskets is from the white leaf willow (*Salix argyrophylla*) and is sewed with California sedge (*Carex barbaræ*). The baskets are made in pattern black and white, the black being from the root of the California sedge. The larger basket is .18 × .10 inch, with the opening .06 inch across, and weighs one fourth grain. The smaller basket is .10 × .04 inch, with an opening .04 of an inch across, and weighs one twentieth grain. Both baskets are woven in the same manner as large baskets and carefully patterned. The Pomo Indians, located in northern central California, are noted for their basketry, which is unrivaled in North America, for workmanship, beauty and variety of designs. The women are the weavers, but the smaller basket was made by a man who is one of the few men weavers among the Pomo Indians.

GEORGE T. MOORE,
Corresponding Secretary

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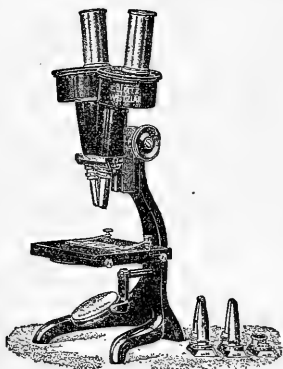
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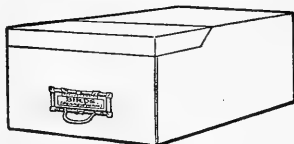
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MSB, intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE PRESENT EDUCATIONAL SYSTEM AND THE TRAINING OF ECONOMIC ENTOMOLOGISTS¹

At the beginning, I wish to call your attention to the fact that this paper deals with a system and its relation to the preparation of a class of men to meet certain insistent economic conditions brought about by a twentieth-century civilization. I do not wish to place the instructor in any other position than that of a more or less willing or unwilling agent of this system, or the university graduate in any other light than that of the inevitable result of the workings of that system.

The world of to-day demands the carrying out of certain undertakings, the doing of certain difficult things, which, in turn, demands certain qualifications in the men who are to do them, and demands them as never before in the world's history. These men must be taken as lads and so trained as to meet these imperative demands. Where can the American boy get this preparation that these existing conditions demand? Who has the ability, willingness and the freedom to train him therefor? If I were the only one asking these questions, or were the science of entomology alone involved, there would be grounds for suspecting that there was something wrong with the entomologists. But this is not the situation.

Several years ago Mr. F. W. Taylor, who is not only not a man with a grouch, but one of the foremost engineers in the country, stated that he had long ago made up

¹ Read before the Washington, D. C., meeting of the Entomological Society of America, December 27, 1911.

his mind not to employ another college graduate unless the latter had either worked outside in a shop for two years or else had been forced out of school and into practical work. Not only this, but Mr. Taylor goes on to say that the overwhelming majority of employers of this country want nothing to do with college graduates, if they can help themselves, until after they have been tried out, so to speak, outside the university.

More recently Mr. R. T. Crane,² a Chicago manufacturer, of nearly sixty years' experience with, as he tells us, all classes of men, is even more dissatisfied with the output of our colleges and universities and is much inclined to, unjustly, throw overboard all technical training, although evidently fully recognizing the importance of the practical application of science.

The self-educated or self-made man must, almost of necessity, possess an iron will, preferring to override obstacles that obstruct his way, rather than to evade them. He is, on the whole, more liable to become dogmatic, thus going to extremes, and to permit prejudices to obscure reason, than is his fellow with a technical training.

Railway people who are on the watch for men of action tell me that they like the university man with the technical training, provided he will have devoted his vacations to their temporary employment, thus carrying the theoretical and practical features along together.

The foremost electrical concern in this country, the Westinghouse, also likes to get college and university men, but is mighty careful not to let them get where they can do any damage, until they have given them a training in their own practical school.

Now it is not to be supposed that the instructor in entomology will be given advantage over his colleague, the instructor

in engineering, or that his students will be allowed to follow a special educational system of his own. Indeed, he is lucky if he is able to secure even equal privileges and facilities for carrying on his work. It can not, therefore, be supposed that graduates in entomology will be any better qualified than those in other courses, and I am sorry to say they are not.

During the last twenty years, including the present, I have had with me between forty and fifty assistants, nearly all college and university graduates, and I tell you candidly I would not take another one fresh from school and with no further training, were I not obliged to do so. Indeed this is true in general. All like college and university trained men, but after they have been made over elsewhere. Now, what is the matter?

The most of those who gave university instruction to the men who afterwards worked under me are here before me, and I fully believe that, had I been placed in your position, I probably could not have done better, perhaps not as well. Besides, the university graduate is not suffering from too little instruction, but from too much of it. He has had anywhere from fourteen to eighteen years of continuous, miscellaneous instruction and instead of his mind being clear and penetrating, it is more apt to be clouded and befuddled. As Bacon puts it, "The education of the senses neglected, all after education partakes of a drowsiness, a haziness, an insufficiency which it is impossible to cure." The man fresh from the university classroom is overloaded, not with what he needs but with that which he does not require; he is afflicted with dyspepsia of the brain, or mental indigestion, and until he gets rid of these ailments he is of little use. This is why there is so much aversion to employing them in practical work or investigations.

² Lately deceased.

It requires, as Mr. Taylor has stated, two years of actual outside work before they can be at all profitably employed.

Now, I do not believe that such conditions as these are necessary to a college or university education, but that the cause therefor will be found in the methods employed. If we go back to medieval times and for a considerable period thereafter, we find but scant literature, and that little accessible only to the few. Therefore instruction was of necessity oral and knowledge obtained only at great cost was retained only by committing to memory with the utmost exactness. Thus was an educational system born of necessity and fitted to the conditions existing at that time. A pupil must not only receive instruction exactly as imparted, but must be able to show by examination that he could repeat what he had heard with the same minute exactness, otherwise what he had obtained would be erroneous and, therefore, of no value.

Let us now come back from medieval times to the twentieth century. To an age when ships disabled at sea may make their situation and location known a thousand miles away and receive aid from other vessels within reach, though not within sight; to an age when you can, within a few hours, communicate with your friend, whether he happens to be in Tasmania, Alaska, Capetown or Hong Kong; to an age when, if a married man, you can, seated in your hotel here in Washington, bid your wife good-night, whether she be in Boston, Chicago, St. Louis or New Orleans; when you can board a floating palace in New York and within five days step out of it in England; and when you enter a railway coach in Chicago and in three or four days step out of it in either Portland, Oregon, San Francisco or Los Angeles; or, you can leave Chicago in the same way and in

eighteen hours walk the streets of New York City.

From a time when a serious question arose in the minds of men as to whether or not insects were the results of spontaneous generation, to a time when insects from all quarters of the earth are being transported about from one country to another and reared up in myriads to destroy other insects. Within the memory of some of us, the entomologists of America could be told off on the fingers of one hand, and these were engaged in describing genera and species in a way that to-day is in many instances practically unintelligible. Some years ago, I tried to get, from a man who had grown up from boyhood with Dr. Asa Fitch, some information regarding this one of the fathers of economic entomology. What I did succeed in learning was this: "Fitch was a queer fellow, always prying into things that the Almighty never intended us to know."

Thirty years ago a state entomologist in the middle west resigned his office, telling his friends in confidence that economic entomology had reached its limit, and, so far as he could discern, there would soon be nothing for the entomologist to do. At the close of A.D. 1911 the question is to get men properly trained to carry on the work that state and nation demands to be done. There is hardly a civilized people on the face of the earth among whom there are not to be found officials who are entomologists. Not a year passes by during which some of these may not be seen here in Washington, studying our methods of work, our collections, especially the former. One of America's foremost philanthropists is sufficiently aware of the importance of this to supply the necessary funds to enable these men from other countries to come and see for themselves how the science of entomology is being profitably applied in this

country. Now, these gentlemen from abroad have access to all of our publications; can read of what we do and how we do it. They could probably read up and go before an examiner and get an excellent grading on their replies, yet it is significant that a practical business man should think this insufficient, so much so that he willingly pays the expenses of such men to enable them to get into closer touch and see for themselves how investigations are carried on, the facilities required and the methods employed in their use.

There is another phase of our present-day entomology that, in passing, I wish to note, and that is the great desire among systematists for the examination of types, the desire to see and handle the precise insect that Say, Harris, LeConte, Grote and others, both at home and abroad, had before them when they described a species and gave it a technical name. Men will travel hundreds of miles, and visit foreign lands in order to do this. Now, all of the descriptions of these are in print, all can be committed to memory and a man with ordinary intelligence could go into a classroom and pass a most excellent if not indeed a perfect examination, all that you could possibly require of a student. Does not this of itself show clearly that, whether it be a university student of twenty or thereabout, or an independent student, official or amateur, of thrice that age, he must study the things themselves? You can not make up-to-date entomologists within the walls of a classroom.

Dropping, for the time being, the subject of present conditions in the matter of progress, let us take up the educational system under which the men who are yet to come into action are to be educated.

Coming from an era when oral instruction and memorizing were imperative, through an era when the educated were the

priest, the astrologer, the alchemist and the philosopher, with a few of the nobility, the remainder being illiterate and therefore ignorant and brutal, when that now powerful educator, the public press, was as yet unknown, and the almost equally powerful educator, the public library, was inaccessible to all but the few, this system has come down to our radically different twentieth-century civilization, unfortunately, deplorably intact. Indeed, what was once a necessity has now become sadly perverted. Once, the student must of necessity listen and memorize with exactness what was told him, and pass a most rigid examination. Now, however, the object appears to be to get the student to remember long enough to pass his examination. It is of such that Huxley says: "They work to pass, not to know; and outraged science takes her revenge. They do pass, and they *don't* know." Count Leo Tolstoi years ago wrote that he had become convinced that written or verbal examinations were a relic of medieval scholastic superstition, and that in the present order of things, they are decidedly impossible and only harmful. And, again, Huxley says, in his twenty years' experience as an examiner, from boys and girls of elementary schools to candidates for honors and fellowships, that it was a clear case of familiarity breeding contempt, and his admiration did not wax warmer as he saw more and more of its workings. In his opinion, examination is a good servant but a bad master, and he expressed the fear that it would sooner or later come to be the master.

But, you will ask, what has all of this to do with the entomologist, whom you have hardly mentioned? Practically nothing, gentlemen, for the reason that from the age of six years, when he entered the primary school, until he is eighteen or twenty,

or half way through his university course, he is not supposed to have any idea of what his future is to be—what he is to do in this busy world. And his education has been given with no reference to whether he is to be a doctor, lawyer, engineer or entomologist. He has simply drifted with and been one in the procession. But between his senior year in high school and his entering into the university he must pass an examination. I have just shown the value of this and all other similar examinations in forming an estimate of what he really knows. In Washington, and possibly, though rarely, elsewhere, a pupil is allowed to specialize in the high school. Here in the city we have a technical high school and a business high school which, although they may not be all that is to be desired among even those most responsible for their existence, constitute a movement in the right direction and should be encouraged both here and elsewhere.

When, therefore, on coming from the high school and presenting himself before the university for admission, where for the first time he is offered separate courses from among which he must make a selection, he naturally expects that his efforts will, or ought, to be directed along a line with what is to be his future occupation; what he is to do in future. But he soon finds that while he may select his course, about the same job lot of instruction will be administered as before.

If he has come to the university of his own accord, as is probably the case, he is like a vessel with steam up, ready to put out to sea. It does not need additional force, what it requires is direction—a pilot with a firm hand and who understands his business. Instead of this, however, the applicant will in most, though not all, cases find himself at once placed in a mental strait jacket, and if it does not fit him

the screws will be applied until he fits the jacket. Incisions will be made in his brain and a heterogeneous mass of instruction forced in. If he can stand the strait jacket and hold the instruction in long enough to pass his examinations, he will be allowed to continue and finally be graduated with much ado and a great flourish of trumpets. If he can not withstand this treatment he is sent home in disgrace.

Mr. Taylor tells us that after he had given up all hope of being able to use as engineers the men who had graduated and gone out from the university, but had been obliged to throw them all overboard until they had spent a couple of years outside in practical work, he found that there was a class going out from these institutions that it paid to look over with a view of securing material for successful engineers; and this was the class that honestly flunked and went back home to work. This, to use a western mining expression, was found to be "pay dirt."

As a matter of fact the embryo entomologist, on his first admission into the freshman class, or as soon as he has decided upon such a course, should be informed that he is there to work; to himself do things and that while there will be examinations he is there to study the science of entomology and not the science of passing examinations. In order to enable him to meet these requirements he should be given first that for which there is the greatest need, and thereafter he should be provided with what he needs, when, and not before, his progress requires it, precisely as with any other tool or instrument.

His first requisites will be honesty and good judgment. If he does not already possess these, he had best stay out of entomology, or any other science, for that matter. His mission, if he succeeds, will be to penetrate the unknown and tell his col-

leagues and the world precisely what he has seen. If he can not do this with strict honesty and good judgment his efforts will be worse than useless. Just the extent to which the present system of recitations and examinations tends to develop honesty and common sense I, for one, have never been able to clearly determine.

Having gained admission and taken up his freshman work, his first need will be that of language. As an investigator he will be required to penetrate the unknown and tell in clear unmistakable language what he saw there. In my own division of the Bureau of Entomology there are, or have been, over twenty-five individuals, engaged in certain investigations, whose field notes, including name of observer, locality and date, are finally copied on library cards and filed in the office under the name of the insect to which they refer. No one can tell when the information contained in these records may be required for use, who will make use of it, or where the original observer will be at that time. He may be one, two or three thousand miles away, even in another part of the world. Therefore, his records must be clear, concise, including every detail, but excluding every superfluous word, in order that any other of the division may be able to understand precisely what the observer intended to state. While the capacity for doing all of this should be attained in the freshman year, as a matter of fact if you find more than one out of every ten or fifteen university graduates who can do this you may consider that you have found an exceptional group. This seems to be one of the requisites, not obtainable in a university course, but which must be secured later.

If the student has not already had a couple of years of Latin in the high school he might take it up at once, for the reason that it contains the key to nearly one half

of the English language, while German holds the key to almost all of the other half. Both German and French are especially rich in scientific literature to which he must have easy and intelligent access. In his case, it is not a classical but a practical working knowledge of these languages that is demanded, and if any of these languages are eliminated it should be Latin. With him it is not a text-book, but a business acquaintance with languages, that he requires. He will very early become aware that the German and French scientific literature with which he will come in contact and which he must read in the original and comprehend, is quite different from that of the classroom. He will be obliged to purchase dictionaries and do a lot of self-education that will not be recognized in ordinary examinations. This need not discourage him, however, as, probably, his instructor would have to do the same thing. A professor of Greek in a theological university once told me, on returning from a summer's sojourn in Greece, that he got on very well after he had become familiar with the language. Also, at the outset the student should have elementary entomology, but it should come in the way of elementary zoology with especial reference to insects. Just what text-book is to be used here I shall leave to the instructor in entomology. Those who write text-books in zoology usually know little of insects, and it is perhaps as well that they do not give more about them. The student will need to refer to considerable literature any way, and the library is the best place to be found for keeping text-books; the more they are kept and used there the better. Entomology should be studied during the warm seasons of the year when insects are alive and active, but somehow it happens that when insects are alive the student who should study them in that condition is too

deeply engrossed in the study of dead languages. This leaves only short periods in fall and spring during which it is possible to observe living insects in the woods and fields. These brief periods should be employed to the best advantage and the student should be told, at the end of the first week of the opening term, that a large quantity of material will be required for laboratory work during winter; that the institution does not regularly supply this except for reference purposes; that it is to be found in plenty in fields and woods, where he must himself procure and preserve it for future use. He should be informed that, right then and there, the system of grading, of merits and demerits, that will be in vogue during his university career will be put into operation, and he should be marked on the quantity, condition and proper preservation of this material. The instructor should by all means be able to spend one or two afternoons each week during good weather in the fields and woods with his students. This will encourage and develop their habits of observation and enable them not only to see things, but learn where and how to find insects and properly preserve them. This last faculty appears to be another factor in the education of an entomologist that frequently there has not, in his four years' training, been time to look after. Probably any one who saw the condition of material sent to the bureau or National Museum for determination would get the same impression. As a matter of fact, all of this should be required in the freshman year and the student marked on the quality of his work precisely as if done in the laboratory. He will and indeed must learn by experience that imperfect, dirty and improperly preserved insects are unsatisfactory subjects for study. It is said that an entomological instructor, in a fit of desperation, sent an

unusually dull student to the college collection to find out the number of legs an insect possessed. The poor fellow, after being out for a considerable time, returned and reported that most of them were possessed of from one to five legs, but occasionally one was found with as many as six legs.

Laboratory work means so much and is so far reaching that it is impossible to overdo it. It is here that the instructor gets the closest to his students and all work together almost like colleagues, thus giving him the opportunity of his life to study his pupils and correct their individual defects. Then, there are so many things that enter into laboratory work, on which the instructor can grade students with absolute justice, developing the traits that we who are to use them later on are so anxious to see in them. I would rather have a few days with a man in the laboratory or field than copies of any number or all of his examination papers.

He should be required to make full notes which may be graded both from an entomological and a literary point of view; he should make drawings, both free-hand and otherwise, dissections and descriptions. Besides an endless variety of rearings, breedings and interbreedings can be carried out.

The aim throughout the entire university course should be to eliminate teaching or instruction just as much as possible, and substitute therefor direction, encouragement with insistence upon accuracy and completeness. The only help given a student should be that which affords the greatest aid in enabling him to help himself. Make him work and do it properly. You who are training entomologists are already doing altogether too much teaching. Fully one third of the energy of the university instructor is being thrown away on account

of being misdirected. Not only does the student fail to profit by this, but it is detrimental instead of beneficial.

Just here I wish to interject an innovation which, if carried out, would mean a great deal, not only for the student himself, but for the one into whose hands he will fall after graduation.

Let the student spend all or as much as possible of his vacations in actual field work under competent entomologists. This work should count in credits for graduation and should be based upon efficiency and quality of work done. At present, he must report for duty at his own expense, often long distances away, which, with the limited compensation he could command, would not be profitable. But if his work counted for credits in the university, he might well afford the expense involved.

In his sophomore and junior years the student will require a knowledge of botany, sufficient to enable him to recognize plants and assign them to their proper family, or genera if common. Beyond this, an entomologist had better consult a botanist. He will need some knowledge of chemistry, geology, climatology, physics, comparative zoology, comparative anatomy, morphology and physiology. He must have some training in histology. He need waste no time on higher mathematics. He can get a working knowledge of mensuration, should it become necessary to apply it. He is already being trained in a science having no superior in developing exactness, acumen, and what a knowledge of higher mathematics does not always presuppose, good judgment. Incidentally, let him read Sherlock Holmes carefully and intelligently.

A few years ago a university that could hardly be convicted of underestimating its own greatness, graduated a student in entomology. By dint of hard, practical work

outside during vacation, and in the laboratory, he was fortunately better equipped in entomology than are most graduates; it was not so much a case of graduating first and completing his education afterwards. His trigonometry, however, proved almost too much for him and remained hovering over his head, like the raven of Poe, until the very last, and, even then came very nearly preventing his graduation. He is making good since leaving the university, and has succeeded in forgetting his trigonometry, which cost him so much in both time and energy, but for which he has no more use than he has for navigation; but is still handicapped for the training in histology for which, while in school, he had begged, but was prohibited from obtaining.

In languages, classroom language may well end here, probably with the freshman year, but his training in the contact, absorption, every-day-use kind, will never end. I might say here that the lazy or don't-care fellow has probably found the work uncongenial and dropped out, also during the freshman year. All of the time continue to give laboratory work whenever possible, and outside work, too, if it can possibly be arranged.

At the beginning of the senior year give your student one or more pieces of original work, no matter what so it involves and brings into action all that he has previously acquired; and include embryology, parthenogenesis, polyembryony, or any others belonging to the most advanced entomological work being carried on elsewhere. Direct him, advise him, encourage him, but make him work out his own salvation and learn to take care of himself under any condition or situation. This sort of a man will need no petting or unusual advantages. He wants only a fair chance and a square deal. He will possess a certain species of solid independence that is quite the reverse

of snobbishness. He will be completely educated before graduation instead of only in part, the remainder to come afterwards. His mind will be clear and active like the spring rushing out of the rock, clear as a crystal, unlike that of a mud puddle just after a summer's thunder storm.

Instead of taking such a man as an experiment, at \$1,000 per year salary, without much of an idea of what I am really getting, I would be only too glad to recommend his appointment at \$1,500. In the first instance, if sent perhaps a thousand miles or so away, he will expect to be told just what to do and how to do it. In the second case, he will keep both mail and wires busy piling up letters and telegrams telling me what he is doing and how he does it. The one must be bolstered up, the other can not be kept down. Your senior needs no teaching or instruction. He does require judicious, kindly but firm direction and you have almost made his future.

Some things are, however, amusing, even in serious matters. Quite possibly in case of the \$1,000 man, his college paper may contain something like this: "Mr. A. B. C., '10, has just accepted a responsible position with the United States Department of Agriculture at Washington. University of X. Y. Z. men are much in demand by this great nation, and this demand appears to exceed the supply." When similar information is allowed escape from the president's office, even with an eye to increased appropriations, the effect is doubly demoralizing.

Now, as I have already explained, the amount of teaching and instruction required will be vastly reduced, but the effectiveness will be correspondingly increased. You will say, however, that I am dealing with only one phase of the problem, that of training the investigator, and

have lost sight of the systematist and teacher.

Relative to the first, let me tell you that the systematist must in future become more and more of an investigator, and, moreover, of precisely the sort I am urging you to develop. Our present system of insect classification is all well enough if you put it away and keep it in Schmitt boxes. The moment you remove it and attempt to build a biological structure upon it, it breaks down. It is too frail and loosely put together. Let me illustrate. Some years ago we had a parasite of a very destructive aphid down in our books as *Lysiphlebus tritici*. In carrying out our investigation it became necessary to find out whether this parasite had more than a single host insect, and whether it could develop in more than one species of aphid. To this end, recently emerged males and females were allowed to pair, after which the female oviposited in several species of aphids. Both parents were then killed and preserved and all of their progeny not used in further experiments were also preserved, and thus entire broods or families were kept together. In this way females were reared out of one host species and allowed to oviposit in others until often after several hosts had been employed it would be bred back into the species whence it first originated. In all cases the host was reared from the moment of birth, while with the parasite both parents and offspring were preserved and kept together. The result of this little fragment of work was to send two genera and fourteen species to the cemetery—you may call it Mt. Synonym Cemetery if you choose—while the insect involved is now *Aphidius testa-ceipes*. The systematist who studies only dried corpses will soon be out of date.

Now as to the teacher: there has of late grown up among universities and colleges

a traffic, of which you will find no record in commercial literature—the training of teachers and exchanging with each other—a commerce that is indicated in university and scientific publications. This is a kind of intellectual in-and-in breeding. Among animals and plants this is only practised where the intention is to establish a fixed type that will not change but remain stable. Hence it is that your type of teacher and teaching is so fixed and to a certain degree inflexible. A teacher instructs as he was himself taught to do—taught that it was the one and only way. If he departs therefrom to the extent of substituting direction for instruction he feels as though he was a discordant note, and has somehow done something not just right.

This is not intended so much as a criticism as pointing out the fact that it simplifies correction. The matter is one that the pedagogue can change and correct, because the old method has become antiquated. The time was when the pedagogue could and did decide the sort of training necessary, and perhaps it was, at that time, best that he did so, but times have changed since then. Up to not so many years ago when instruction was even more functional than now it was hard to find a university-trained man in the employ of industrial firms or corporations. Now there are many. There must, however, be still further modifications to meet the still more exacting demands at present made upon university-trained men. The business man succeeds by being the first to see a demand as well as the first to supply it. If you will allow me to put it in a homely way, the pedagogue must get down from his antiquated pedestal that is badly affected both by dry rot and *Lyctidæ* and get on to another, more substantial, of concrete and steel perhaps.

You can not suppose, for a moment, that

we can carry on investigations that, ten years ago, we would not have dared to touch, with men trained just as they were ten or twenty years ago. This is far from being a personal matter. It is our irresistible, progressive civilization, the pride of every American, that calls for improvement, and it must come. Slowly, perhaps, but surely.

It has not been my aim in this paper to unduly criticize the progressive instructor, or the institution that is doing its best to break away from the old régime, but to encourage and if possible aid both in their laudable efforts.

If I have been able to put into the hands of those who are to train our entomologists for us in future facts or arguments that will aid them to push for a more rational, natural and therefore easier, though none the less thorough and severe, university training, I shall have certainly accomplished all that was intended.

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ON THE IMPROVEMENT OF MEDICAL TEACHING¹

THE watchword of the present is conservation. Especially in the industrial world it has been shown that great improvement is possible by the elimination of needless waste of time and energy. Though not yet so clearly recognized, this is equally true in the field of education. Teachers, especially those in the higher institutions of learning, are notoriously neglectful of the principles and technique of their profession. Unquestionably this results in great losses due to inefficient methods of teaching. These losses, in medical education, may be conservatively estimated at twenty to twenty-five per cent. In other words, the adoption of more efficient methods of teaching would probably enable

¹Read at the twenty-second annual meeting of the Association of American Medical Colleges, Chicago, February 28, 1912.

us to gain the equivalent of a whole year within the time now devoted to the four years' curriculum. Is not the possibility of such a tremendous saving well worth our serious consideration?

At the outset, it should be clearly understood that *uniform* methods of teaching are neither necessary nor desirable. The methods in detail must be determined by the individual teacher to meet best the varying local conditions. But equally true is the important fact that all efficient methods of teaching must be based upon well-known and well-established principles of pedagogy. Efficient teaching requires three essential conditions: (1) Complete mastery of the subject-matter on the part of the teacher; (2) a clear notion of the aim of the teaching, and (3) well-chosen methods of accomplishing the aim. The first and most essential condition, that the teacher must be a master of his subject, is everywhere clearly recognized, and will not be discussed in the present paper. The second and third conditions are those oftenest overlooked, and it is therefore necessary to emphasize certain fundamental principles of aim and methods, the neglect of which is largely responsible for inefficient teaching.

In the first place, let us therefore consider the aim of medical education. In this all will probably agree that the *primary* aim of medical education should be to train efficient practitioners.² And it may furthermore be taken for granted that an efficient practitioner is one who is able to observe accurately, to think clearly and to act wisely in his medical practise.

Keeping in view this primary aim and ultimate purpose of medical education, to train efficient practitioners, we may next consider the methods, the ways and means, whereby this aim is to be accomplished. If the end is to be reached most directly, if the student is to be trained most economically for the great-

est efficiency, it is evident that the instruction must be adapted to his nature and learning capacity. How shall this be done? Let us see whether there is any rational principle to guide us in adapting our methods to the nature of the student. Upon this question an important light is thrown by the history of education.

A century ago, practically all teaching was based upon the doctrine of authority. It was the function of the teacher to *tell* the student what he should know and do. It was the duty of the student to be a passive recipient, to follow faithfully the precepts of the teacher. This doctrine of authority, however, was found inefficient and has long since been abandoned in rational education. It is now generally recognized that all education really worth while is based upon *self-activity*. This principle, advanced by Froebel, is now so thoroughly established in education that it may almost be taken as self-evident. Self-activity is the keynote of modern pedagogy. And yet, while recognized in theory, this fundamental principle is often almost totally neglected in practise. In the light of this principle of education by self-activity let us review briefly certain phases of methods in medical teaching.

In developing the self-activity of the student, it is evident that the methods first of all must arouse his interest and attention. Interest we know to be most intense in things which satisfy conscious needs. Now the medical student wants above all to be a good practitioner. If he knows that a certain thing will help him to accomplish this, he is intensely interested, and will exert an active effort to secure it. "The mind interprets impressions from without, not according to their intrinsic nature, but accordingly to their relation to the needs of the organism" (Bagley). Common sense and good pedagogy therefore agree that in teaching any subject in the medical curriculum, the teacher should make sure that the student realizes its bearing upon his later work.

Some may conclude from the foregoing that, since time is limited, only the so-called

²In addition to the education of practitioners, the medical school has other important functions, such as the advancement of medical science through original investigation, but these are not within the scope of the present paper.

"practical" facts, those that are of obvious utility in the practise of medicine, should be taught, and that no time should be wasted on "theoretical" aspects. While this argument may appear plausible at first glance, its fallacy is apparent on closer examination. In the first place, it is impossible in any given subject to select out only those facts which may later be needed. Moreover, even if such facts could be selected, it would be impossible to teach them as bare, empirical facts, in such a way that the student could understand, remember and utilize them, without a comprehension of the science of which they form a part. The "theoretical," as Bagley states, contributes to the coherence of the various facts and principles as *knowledge*. Its value can not be disputed, for any attempt to "cut out" the "impractical" parts invariably results in the inefficient functioning of the remainder. Short courses that give only the essentials, fifth-rate colleges and normal schools that educate you while you wait, are sufficiently damned by their own products.

There is, it must be acknowledged, some truth in both the "practical" and the "theoretical" points of view. The best methods of teaching will, therefore, utilize both. While each subject should be taught from the theoretical, scientific point of view, at the same time its practical application should be kept constantly in mind. In selecting material to develop the essential principles, those facts should be chosen which will also probably be of greatest intrinsic value for later work. Anatomy, for example, should be taught, not as a mass of empirical facts, but as a special branch of biological science. But in selecting from the huge mass of available data the facts necessary to illustrate the science of anatomy, so far as possible those facts should be chosen that are also of direct, intrinsic value in physiology, pathology and clinical medicine.

If this plan were consistently followed out, and everything excluded excepting facts, especially those of intrinsic value, necessary to develop a scientific basis, a "working-knowledge," for each branch of study, the amount of subject-matter presented in each would be

greatly reduced. We all recognize that the curriculum is now overloaded. It is impossible to teach so much and teach it well. "What men need" (according to Huxley) "is as much knowledge as they can assimilate and organize into a train for action."

To develop in accordance with the foregoing plan the most effective methods of teaching, it is evident that each teacher must understand the curriculum as a whole. The laboratory man must be familiar with the clinical work. But this is not all. Since good teaching must take into account that which has gone before as well as that which is to follow, it is equally evident that the clinical man must be familiar with laboratory subjects and methods. We can not expect the best results in medical education until there is a better understanding and more cooperation between teachers of the various subjects all along the line. As medicine progresses, all phases appear more clearly as varied manifestations of the same underlying biological science, and only when this is realized will the clinical and laboratory work be more closely knitted together.

We have seen that to interest the student and arouse him to self-activity, he should be made to realize that each subject contributes an essential part in training him for the desired end. We may next inquire as to *how* he must be self-active. Since efficiency in practise consists in accurate observation and reasoning, resulting in wise action in dealing with medical problems, his training should develop self-activity in these very lines. He must observe, think and act for himself. For this purpose almost ideal facilities exist in our laboratories and clinics. Unfortunately, however, we are far from utilizing these facilities to their fullest extent. Our methods fail to make the student self-active, especially in observation and reasoning.

First we may consider observation. This can be cultivated only by actual observation of medical phenomena on the part of the student. It is, however, a surprising fact that in many laboratories and clinics there is no opportunity for the student to make an *orig-*

inal observation. Why? Simply because through a pernicious lecture system he has already been told all about what he is to see, before he has ever had a chance to observe it for himself.

It is furthermore a fundamental law of learning (technically the doctrine of apperception) that we can not comprehend new facts except upon the basis and in terms of previous concrete experience. Hence the dictum: "In teaching, always proceed from the concrete to the abstract; from the particulars to the general; from the known to the unknown." It is therefore evident that to give lectures preceding practical objective study not only prevents the exercise of original observation but also inverts the normal procedure in the process of learning.

Much time and energy is sometimes thus wasted in trying to teach by lectures what would be quickly and easily comprehended after the fundamental data had been acquired by objective study. In some schools, for example, the junior year is largely given over to lectures and other didactic work which is supposed to prepare the students for the actual clinical work, the latter being chiefly concentrated in the senior year. This, it seems to me, is a fundamental mistake. If there were only one alternative, it would be better to reverse this order, giving the clinics first, and the lectures later. In actual practice, however, they are best intermingled and closely correlated, care being taken always to provide the objective basis before the more abstract generalizations are considered.

Even when the practical work is placed first, however, it by no means follows that adequate training in observation will result. In both laboratories and clinics it is a common practise as a preliminary step to tell the student (either orally or by printed guides) what he is to see. The student thus is not required, and indeed has no opportunity, to observe for himself. Practically all there is left for him to do is to verify what he has already been told. However valuable this may be, it does *not* develop power of original observation. It is, of course, desirable to precede all

practical work with a brief introduction which will enable the student to proceed intelligently with his work. Such an introduction, however, should be merely for the purpose of explaining technical procedure and of raising questions the answer to which the student should seek by original observation.

The ideal plan is thus for the student to work out everything for himself by the method of discovery. This applies not only to the original observations, but also to the later process of reasoning, whereby we proceed from particular data to general conclusions, and thence to rational action. The method of self-activity may therefore be expressed in a negative way by the following practical rules: Never tell a student anything he can observe for himself; never draw a conclusion or solve a problem which he can be led to reason out for himself; and never do anything for him that he can do for himself.

Unfortunately, however, there are limitations to the application of this method. It is difficult to apply successfully, requiring skill and experienced judgment on the part of the teacher. Lack of time would moreover prevent the student from repeating the history of the race by the method of discovery. But though difficult and slow at first, by working out for himself at least the fundamental data, a solid basis is laid which makes possible more rapid progress later. Time lost at the beginning is thus time gained in the end. We should therefore insist that *so far as practicable* this ideal method be applied for the purpose of training the student to self-activity, in developing his ability in observation, reasoning and action.

As supplementary to the foregoing, it is usually necessary to adopt easier though less effective methods of instruction. Thus where necessary data can not be secured by original observation, they may be supplied by the usual type of laboratory or clinical demonstrations, which the student can verify. Next in value below this as a means of imparting knowledge comes the informal lecture or recitation, illustrated by demonstrations, models, pictures, etc. Next comes the

text-book, and lowest of all in the scale is the formal lecture. Curiously enough, the lecture is also the *easiest* method, by which *apparently* the greatest amount of information is gained with the least expenditure of energy, at least on the part of the student. But this is a delusion. The knowledge thus gained is unreal and transient. It is "in at one ear, and out at the other." As we should naturally expect from the principle of self-activity, the ease of the method is apt to be inversely proportional to the efficiency of the instruction. In order therefore to train our students most efficiently in self-activity, we should use the maximum amount of the more difficult but more effective methods and the minimum of those easier but relatively inefficient.

This will perhaps be made clearer by a brief illustration from personal experience. To learn, for example, the normal histology of any given organ by means of a stained and mounted section, this should first be studied by *original observation*. The students observe the structure with naked eye, low power and high power of the microscope, and without previous description by teacher, book or laboratory outline. They record their observations by sketches and brief notes. The aid of the teacher at this stage should be restricted to questioning the individual students so as to recall related facts previously studied and prevent the student from going too far astray. At first, students are apt to be utterly helpless when thus thrown largely upon their own resources, but they soon develop surprising powers of observation. This "investigation" occupies the first part of the laboratory period. The teacher then informs the class regarding the section they have studied, and discusses briefly their mistakes of observation. He directs them in restudying the section, and in correcting their mistakes. The students now extend their knowledge by verifying the statements found in their text-books. Demonstrations are made to furnish additional data and elucidate the more difficult points. Drawings are finally made by the students, to fix the corrected impressions upon their

minds. At a later class-conference, the students are led to review the facts learned, to correlate and interpret them and to reason out general conclusions or laws of structure. These laws they utilize and apply in the subsequent work. Brief written reviews are also frequently held. Occasional lectures by the teacher elucidate the more difficult phases, and indicate the relations of histology to physiology, pathology and clinical medicine. The results are satisfactory as shown by final examination, both written and practical, and by the extent to which the students are able to retain and utilize their knowledge in later work.

The foregoing method illustrates how students may be trained to self-activity in observation and reasoning, and to a certain extent in application. The application of the generalizations reached by observation plus reasoning, while essential in every subject, is especially characteristic of the clinical work. That the student should be self-active in his clinical work, that to acquire skill in the practical application of his previous knowledge he must "learn by doing," is universally recognized. It is therefore unnecessary to dwell upon this phase of the subject. It may be worth while, however, to remember that, above all, in the clinics, "the main business of the teacher is to render his services unnecessary" (Strayer).

To summarize the foregoing: it has been maintained that in medical education there is great need of more effective methods of teaching. Efficient teaching requires a clear view of the ultimate aim, which in medicine is to train efficient practitioners. To accomplish this aim, rational methods of teaching should develop in the student self-activity in observation, reasoning and action. While some may be unable to accept fully the ideas here presented, all will surely agree that great improvement would result if medical teachers would study more carefully their educational methods. The younger teachers who are so fortunately located could greatly improve their efficiency by taking work in the schools of education connected with the various uni-

versities. Those unable to do this should at least study the principles of pedagogy, which are available in numerous books. Although pedagogical literature deals chiefly with elementary, rather than advanced or professional education, it is nevertheless of great service, for the same fundamental principles extend throughout, from the kindergarten to the university. Among those books which may be recommended as helpful are the following: Spencer, "Essays on Education" (a recent edition, with introduction by ex-President Eliot, in the "Everyman's Library" series); James, "Talks to Teachers on Psychology," etc. (Holt); Charters, "Methods of Teaching Developed from a Functional Standpoint" (Row, Peterson & Co.); Bagley, "The Educative Process" (Macmillan); Thorndike, "The Principles of Teaching Based on Psychology" (Seiler). And in conclusion, permit me to suggest that a more thorough discussion of educational methods and principles in our association meetings, and also in the faculty meetings of our various medical schools, would result in greater efficiency in our teaching.

C. M. JACKSON

UNIVERSITY OF MISSOURI

SCIENTIFIC NOTES AND NEWS

PROFESSOR ABBOTT LAWRENCE ROTCH, founder and director of the Blue Hill Meteorological Observatory and professor of meteorology at Harvard University, died on April 7, aged fifty-one years.

DR. JOHN H. MUSSER, professor of clinical medicine in the University of Pennsylvania and one of the most eminent physicians of Philadelphia, died on April 3, in his fifty-seventh year.

THE second annual award of the Willard-Gibbs Medal, founded by Mr. William A. Converse, will be made by the Chicago Section of the American Chemical Society on May 17, to Professor Theodore W. Richards, of Harvard University. It may be remembered that the initial award of this medal was made last May to Professor Svante Ar-

henius. Professor Richards has chosen for the subject of his address "Atomic Weights." An invitation is extended to all members of the American Chemical Society, who desire to be present on the occasion of this award.

SIR J. J. THOMSON has been elected a foreign member of the Naples Academy of Sciences.

THE clay model for a bust of Commander R. E. Peary has been executed by Mr. William Couper and is now on its way to Florence to be cut in Carrara marble. The bust is a gift to the American Museum of Natural History from Mrs. Morris K. Jesup and will take its place among the other marble busts in the niches in memorial hall.

THE Paris Geographical Society will present Dr. Charcot with its gold medal for the work achieved in South Polar exploration by the *Pourquoi Pas* expedition.

THE council of the New Zealand Institute, at its annual meeting held in Christchurch at the end of January, decided to award the Sir James Hector memorial medal and prize to Dr. L. Cockayne as the investigator, working in New Zealand, who has done most to advance botanical science.

THE Academy of Science, the medical faculty of the University of Havana and several other scientific societies and institutions have passed a joint resolution in which the names of Dr. Carlos J. Finlay and Dr. Aristides Agramonte are presented to the Nobel Prize Commission as candidates for the prize to be awarded in 1912. The resolution points out that Dr. Finlay was the first to claim that yellow fever is transmitted by the mosquito, while Dr. Agramonte is the sole survivor of the United States Army Board composed of Drs. Reed, Carroll, Lazear and himself, which demonstrated the correctness of this theory.

THE magazine *Good Housekeeping* announces that Dr. Harvey W. Wiley, formerly chief chemist of the United States Department of Agriculture, became contributing editor of that magazine on April 1. The magazine has established at Washington a "Bu-

reau of Foods, Sanitation and Health," of which Dr. Wiley will be director.

INSTRUCTORS and students of the forestry department of the University of Michigan entertained Professor Filibert Roth recently at a farewell dinner. Professor Roth's resignation from the University of Michigan will take effect in June, and he will become the head of the forestry department of the College of Agriculture at Cornell University next fall.

DR. J. C. WILLIS has retired from the directorship of the Royal Botanic Gardens, Peradeniya, Ceylon, to become director of the Botanic Gardens at Rio de Janeiro.

DR. EUGEN KUEHNEMANN, professor of philosophy at the University of Breslau, Germany, and recently German exchange professor at Harvard University, has been appointed as the first German university professor to occupy the Carl Schurz memorial professorship established last year in the University of Wisconsin by German-American citizens of Wisconsin and friends of the university.

DR. SEVERANCE BURRAGE has resigned as professor of sanitary science in Purdue University, Lafayette, and will spend several months in Europe, after which he will take charge of the biologic and serum department for an Indianapolis drug house.

PROFESSOR F. W. CARPENTER, of the University of Illinois, department of zoology, has been appointed American reviewer for *Zentralblatt für Normale Anatomie und Mikrotechnik*.

PROFESSOR JOHN T. STEWART, of the University of Minnesota, has been authorized by the regents to attend the National Drainage Congress in New Orleans this month at an expense not to exceed \$100.

MR. DONALD F. MACDONALD, geologist to the Isthmian Canal Commission, has been granted three months leave of absence from his duties with the Commission to make a geological study of the disputed territory between the republics of Panama and Costa

Rica. Mr. MacDonald sailed from Colon for Bocas del Toro, near the Costa Rican border, on April 1. From there he will proceed by small boat and by native porters to the region to be examined.

ACCORDING to a cablegram to the New York *Times* the Austrian Red Cross Society will be represented at the International Conference of Red Cross Societies, which meets in Washington on May 7 to 17, by Dr. Maurice Victor Silbermark and Dr. Yetta Silbermark Reising, who sail by the *Auguste Victoria* on April 16.

MR. ARTHUR S. WATTS was elected president and Edward Orton, Jr., secretary of the American Ceramic Society at the recent Chicago meeting.

PROFESSOR GEORGE GRANT MACCURDY will be the delegate from Yale University to the International Congress of Anthropology and Prehistoric Archeology to be held in Geneva, Switzerland, during the first week of September, 1912.

THE following delegates have been appointed to represent the American Philosophical Society on the following occasions: Vice-president William B. Scott, of Princeton, to represent the society at the two hundred and fiftieth anniversary of the foundation of the Royal Society in July next; Professors Paul Haupt, of Baltimore, E. Washburn Hopkins, of New Haven, Morris Jastrow Jr., of Philadelphia, and A. V. Williams Jackson, of New York, as delegates to the eleventh International Congress of Orientalists, to be held at Athens on April 7 to 14; Dr. Franz Boas, of New York, a delegate to the eighteenth International Congress of Americanists, to be held in London from May 27 to June 1. At the centenary of the Academy of Natural Sciences on March 19 to 21 the society was officially represented by Professor Henry F. Osborn, of New York, Dr. Charles D. Walcott, of Washington, Mr. Samuel Vaucain, of Philadelphia, Professor Wm. Bullock Clark, of Baltimore, and Dr. Henry H. Donaldson, of Philadelphia.

THE tenth annual meeting of the South African Association for the Advancement of Science will be held in Port Elizabeth from July 1 to 6, under the presidency of Dr. A. Theiler. The sections and their presidents are as follows: A, astronomy, mathematics, physics, meteorology, geodesy, surveying, engineering, architecture and irrigation, Mr. H. J. Holder; B, chemistry, geology, metallurgy, mineralogy and geography, Professor B. de St. J. van der Riet; C, bacteriology, botany, zoology, agriculture, forestry, physiology, hygiene and sanitary science, Mr. F. W. FitzSimons; D, anthropology, ethnology, education, history, mental science, philology, political economy, sociology and statistics, Mr. W. A. Way.

THE fifth of the Weir Mitchell lectures of the College of Physicians, Philadelphia, was delivered on March 29 in Mitchell Hall, by Dr. William H. Howell, of the Johns Hopkins University, on "The Factors concerned in the Coagulation of Blood and their Variations under Pathologic Conditions."

UNIVERSITY AND EDUCATIONAL NEWS

THE board of directors of the Knights of Columbus announces that \$385,000 of a \$500,000 endowment fund for the Catholic University in Washington already is in hand. The income from this fund, the remaining \$115,000 of which has been subscribed, will be used to provide scholarships for fifty students.

THE Berlin correspondent of the *Journal* of the American Medical Association writes that according to the official estimate of the expenses of the Prussian universities, for the fiscal year 1912, they will amount to \$5,016,389 (20,065,556 Marks). Of this amount \$2,202,058 is to be spent for institutes, collections and the university religious services. For salaries, remuneration and other personal expenses of the professors, instructors, officers, assistants and employees \$2,059,466 are allowed and for lodging allowance \$288,687. For the expenses of the academic management \$93,266 are appropriated, for the building expenses \$200,275 and for taxes \$9,868. For contingent expenses \$110,970 are provided,

and \$51,195 are appropriated for relief and stipends. The entire expenses are distributed among the individual universities as follows: Berlin, \$1,184,515; Breslau, \$541,311; Halle, \$546,982; Bonn \$485,146; Kiel, \$482,741; Göttingen, \$463,215; Königsberg, \$411,621; Greifswald, \$366,475; Marburg, \$348,326; Münster, \$168,158, and Braunsberg, \$17,395. The expenses are to be met by the following income: from the state fund, \$3,636,801; from endowments and other funds, \$178,928; interest from capital and the income from real estate, \$119,619, and from their own earnings, \$1,081,039.

PLANS are well under way for the new building for the department of clinical medicine at the University of Wisconsin. The department exists for the purpose of looking after the health of the students in the university. There is a corps of five doctors and four trained nurses who are kept busy ministering to sick students or taking precautionary measures in the case of those exposed to disease. The new building will have ten offices on the first floor for the treatment of common ailments, and in the basement will be a sterilization room and special treatment rooms, fitted up with X-ray machines, baking machines and other special equipment. The value of having a department to look after the health of students is shown by the fact that there have been no epidemic diseases among the students that were not controlled as soon as the first cases appeared, since the establishment of the department. Previous to its establishment, there were a number of bad epidemics among students, the most serious of which was an outbreak of typhoid fever in 1907 which resulted in the death of several students.

THE *Journal* of the American Medical Association states that the professors of the University of Dijon have unanimously passed a resolution calling for a university congress to organize the French universities more closely and to extend their influence abroad. There has been founded under the auspices of the France-Amérique committee a league to foster French interests in America, which

has for one of its objects to make known to the public of the two Americas the value of French general culture and practical instruction.

DR. CHARLES E. MARSHALL, professor of bacteriology and hygiene in the Michigan Agricultural College, has accepted an appointment as director of the graduate school and professor of microbiology, at the Massachusetts Agricultural College. He will begin his new duties on September 1. The Graduate School of the Massachusetts Agricultural College is an outgrowth of graduate work started under the direction of Professor Charles H. Fernald nearly eleven years ago. Four years ago the school was organized with Professor Fernald as director, and since his retirement Dr. Henry T. Fernald has been acting director. During the existence of the school fifteen men have been given the degree of master of science, and seven, the degree of doctor of philosophy. At the present time sixteen men are enrolled as graduate students. It is the intention of the trustees to develop the activities of the school.

DR. RAYMOND A. PEARSON, recently Commissioner of Agriculture for the state of New York, has accepted the presidency of the Iowa State College of Agriculture at Ames. Dr. Pearson has been granted leave of absence for the summer and will visit agricultural colleges in Europe.

DR. THOMAS McCRAE, A.B., M.D., Toronto, associate professor of medicine at the Johns Hopkins University, has been appointed professor of medicine in Jefferson Medical College, Philadelphia, to fill the chair vacant by the resignation of Professor James C. Wilson.

At the University of London Professor F. G. Donnan, F.R.S., has been appointed to the chair of general chemistry at University College, in succession to Sir William Ramsay. Dr. L. N. G. Filon, F.R.S., has been appointed to the Goldsmid chair of applied mathematics and mechanics to succeed Professor Karl Pearson, who resigned this chair on his appointment to the Galton chair of eugenics.

DISCUSSION AND CORRESPONDENCE

ARE HORNS IN SHEEP A SEX-LIMITED CHARACTER?

ARKELL and Davenport in *SCIENCE* for March 8, 1912, answer this question in the affirmative on the basis of certain crosses which they have made between horned and hornless races. In doing so they call in question the authenticity of a statement made by me in a recent publication as follows:

In merino sheep the male has well-developed horns, but the female is hornless; yet if the male is castrated early in life no horns are formed.

They comment thus:

He gives no reference for the last statement; and in view of the variability of the horned condition in the males of the "merinos" the conditions of the experiments would have to be carefully considered before such a result could be accepted as settling the question of the dependence of horns in heterozygous males upon a secretion from the testis.

In reply to this criticism, I beg to say that I gave no authority for the statement in question because I can myself vouch for it. I grew up on a farm where Merino sheep were kept in considerable numbers. From my earliest recollection until I was 21 years old I saw the operation of castration practised each year on 50 or more ram lambs and its effects were perfectly familiar to me. The result is exactly that stated. If the male is castrated early in life, say within a month after birth, no horns develop. If castration has been delayed for two or three months, the horns begin to grow, but castration then promptly arrests their growth. I can recall but one exceptional case in the hundreds that came under my observation. In that case the horns continued to grow for some weeks. When this case was observed, the animal was caught and found to have been imperfectly castrated. A second operation caused cessation of the horn development. My father used registered Atwood Merino rams, and his ewes were pure bred. The ewes were regularly hornless as they are typically in this breed. See figures in Robert Wallace's (1907) "Farm Live Stock of Great Britain," p. 592. The males were as regularly horned, if not castrated. We usually

raised several of these (uncastrated) males each year and they were remarkably uniform in horn development. Compare again Wallace's figures, which are accurate, being photographs. Arkell and Davenport's statement concerning the "variability of the horned condition in the males of the Merinos" leads me to think they must refer to *grade* Merinos, certainly not to the pure bred ones.

To my mind the evidence is clear that in pure Merino sheep castration does prevent development of the horns, and I have no doubt that in other breeds also castration has similar though perhaps less conspicuous effects. In breeds which are horned in both sexes the males regularly have *better developed* horns than the females, and castrated males have smaller horns than uncastrated ones. See figures in Wallace.

If castration has the effect stated, the assumed nuclear *inhibiting* factor of Arkell and Davenport is quite superfluous. Their experimental results are fully in accord with those of Wood and are fully covered by the simple statement of Bateson that the horned character is "*dominant in males and recessive in females.*" Why this is so I have attempted to point out. Presence of the testicle is necessary for full horn development, in some breeds it is necessary for *any* horn development. Reasoning from the experimental results obtained in poultry it seems probable that injections of testicle extract into the female would cause increased horn development similar to that of the male. It would be interesting to know whether the testicle of all breeds would behave alike in this experiment. Whether the female sex gland acts as an inhibitor of horn development would be a wholly different question, yet one capable also of experimental solution.

To assume, as Arkell and Davenport do, that inhibiting factors present in *X*-chromosomes affect the horn development seems to me unwarranted, for the simple reason that neither inhibitors nor *X*-chromosomes are known to exist in sheep. That Guyer has recognized the existence of an *X*-chromosome in man has no very direct bearing on the

question, but even Guyer's result is unconfirmed by Guthertz, who has reinvestigated the spermatogenesis of man upon exceptionally favorable material.

Arkell and Davenport reason thus:

The results of the table [of crosses] accord very closely with expectation, so that we are justified in concluding that an explanation of the results like that we offer is the correct one.

But Bateson's explanation accords also; wherein lies the superiority of the new one offered? To establish the probable correctness of a hypothesis it must be shown that no other hypothesis accords with observed facts equally well. Has this been shown in the case before us?

Consider how one unproved hypothesis has been added to another. First it is assumed that in hornless animals a gene for horns has either been lost or is inhibited. It is equally probable that no gene has been lost and that nothing is inhibited. Secondly, it is assumed that one inhibitor is inferior to one horn-gene in power, but that two inhibitors surpass one horn-gene, yet two inhibitors are themselves overpowered by two horn-genes; without all three of these ungrounded assumptions of the relative valency of imaginary genes the explanation fails altogether. Further, it is assumed that the female is capable of carrying two inhibitors, but the male only one. And finally when this colossal structure of hypothesis encounters one well-known physiological fact, the result of castration, that fact is calmly brushed aside. Is this a desirable extension of Mendelian interpretation?

W. E. CASTLE

March 13, 1912

THE MOTH OF THE COTTON WORM (ALABAMA ARGILLACEA HUBN.)

TO THE EDITOR OF SCIENCE: In connection with the notices appearing in SCIENCE (October 16, November 10 and December 29), concerning the moth of the cotton worm and the destructive work of the caterpillar on cotton, a note from Missouri may be of interest.

During the fall this moth was present in great numbers in various parts of the state.

The northward migration seems to have been quite general. They made their first appearance in the vicinity of Kansas City early in September, and by September 28-30 were present in countless swarms at Kansas City and Holden. They reached Macon in north Missouri September 24, and were very abundant and troublesome until frost. Here at Columbia they were especially abundant the last two weeks of September and early October; while later in October the moth of the army worm (*Leucania unipunctata*) was far more abundant, collecting about cider mills and injured and decaying fruit. With conditions favorable next year, we may expect considerable injury from the army worm in this state.

One point with reference to the moth of the cotton worm which the other notes have not brought out, is the injury which they do to ripening fruit in the orchard and where fruit is exposed in the market. This has been especially emphasized in all the letters received at this office this fall. As is well known, this moth has rudimentary mandibles by means of which it can break the skin of fruit and then with its proboscis it sucks out the juices. Late peaches, especially Heath Clings, are reported as having been severely injured this year. In some cases a dozen or more at a time collect on a single peach and eventually all the juice is consumed, leaving only the skin, pulp and pit. Grapes and even bananas in the market are attacked. In the orchard, after the peaches were picked, the moths turned to the apples. Their attack on the apple is similar to that on the peach except that the juice is drawn out in patches which turn brown and become mellow like bruises. The affected patches vary from the size of a pea to that of a dime or a quarter. The most of the fruit so attacked decays.

The strange northward migration of this moth which has always been of considerable interest to the entomologist has proved to be of special interest to many of the Missouri fruit growers this year.

LEONARD HASEMAN

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CRYSTALLOGRAPHIC TABLES

TO THE EDITOR OF SCIENCE: As a teacher of crystallography I have found that students rarely appreciate the full significance of the fundamental laws of the science until, by actual measurement and calculation, they have found concrete evidence. With large crystals of quartz, calcite, tourmaline, zircon, rutile, barite, staurolite and a number of others, satisfactory results may be obtained by use of the Penfield hand goniometer. The advantage of such crystal measurement is twofold; it illustrates the laws which govern the arrangement of crystal planes, and it teaches the value of the science as a means of mineral determination.

Regarding the latter phase of the study, students are taught the methods of measurement and calculation necessary in each system for the determination of axial ratios. To bring out clearly the real value of such calculations as a means of practical mineral determination some sort of reference table of axial ratios seems desirable. Such tables have been compiled in a somewhat imperfect form, and it is to these that attention is directed.

The axial ratios of common tetragonal and hexagonal minerals are arranged in ascending values of c , the mineral names being placed in a parallel column. In practise the chart is placed before a class with the mineral names covered. After careful measurement and calculation the student refers to the column of ratios, and the fact that he can, in many cases, determine the mineral properly by this means alone, makes it a most illuminating and interesting exercise.

The orthorhombic system presents considerable difficulty in compiling a table of ratios since there are three possible ways in which the values of a , b and c may be arranged and still be in accord with the convention that b must be greater than a . Having determined the axial ratios, one is in doubt as to the proper arrangement. The three possible values of a , which may occur, b being unity, are the value of a when (1) c is greater than a and also greater than b ; (2) c is greater than a and less than b ; (3) c is less than a

and less than b . The most useful table, one which precludes the necessity of rearrangement or recalculation, is one which includes all three of these possible values. For the most common orthorhombic minerals such a table has been arranged with the values of a in increasing order of magnitude, the corresponding values of c and the mineral names being placed in parallel columns. Thus each mineral appears three times, and the value of a accepted by convention is underlined. The corresponding value of c in the parallel column is a very useful check in tracing the unknown mineral.

If a monoclinic mineral is held with the greatest possible number of faces vertical, the most probable mistake in orientation is the interchange of a and c axes. Hence the table is made to include both a and c as possible values of a , *i. e.*, each mineral appearing twice in the table.

Would such tables, enlarged to include all minerals for which axial ratios have been determined, be useful accessories in the work of crystallographic mineral determination with the reflecting goniometer? Would tables further enlarged to include artificial crystals be of use to the chemical crystallographer?

Before undertaking such a task one wishes to know if it is worth while, and for this reason the questions are presented. Suggestions, and the utmost freedom of criticism by teachers of crystallography, are invited.

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HOUSE AIR

TO THE EDITOR OF SCIENCE: I had occasion recently to consult the issue of SCIENCE for September 29, 1911, and read for the first time the letter on "House Air" from Professor J. Y. Bergen, of Cambridge.

He makes this statement regarding the ventilation obtained from a hot air register:

The ventilation . . . is much better than can be obtained in summer by opening a single window to its full height.

It is doubtless known to him and should be

more widely known that it is better to pull the window down a couple of inches from the top and up from the bottom when ventilation is required than to open either half only. The truth of this statement can easily be tested by holding a lighted candle at the window openings.

G. L. MANNING

ROBERT COLLEGE,
January 23, 1912

QUOTATIONS

MOST RECENT INVESTIGATIONS ON THE DETERMINATION, PRESERVATIVE ACTION AND ADMISSIBILITY OF THE USE OF BENZOIC ACID¹

PART II²

I NOW come to the most important part of my work—a critical summary of the three detailed investigations on the effect of benzoic acid and of benzoates on man which have been carried out during the last four years and which now furnish us that broad basis, which I have always desired, necessary for the formation of an intelligent opinion. First, there are two great works from the American Department of Agriculture; one carried out by H. W. Wiley,³ in 1908, the other by a commission, under the chairmanship of the distinguished chemist, Ira Remsen, consisting of the three well-known American scientists, Professor Russell H. Chittenden, of Yale University; Professor John H. Long, of Northwestern University, and Professor Christian A. Herter, of Columbia University, New York. It seems strange that a great government should publish two books, one right after the other, dealing with the same subject-matter; and we seek in vain, in the second large volume of 761 pages, for a word of explanation of this surprising fact. Wiley's work is simply ig-

¹ Translated from the *Chemiker-Zeitung*, Cöthen, November 28, 1911, pp. 1314-17.

² Part I. (*Chem. Ztg.*, 1911, pp. 1297-99) is a summary of the articles dealing with the isolation, qualitative and quantitative determination, natural occurrence in plants, preservative action, use and toxic effects of benzoic acid.

³ *J. Soc. Chem. Ind.*, 28, 67 (1909).

nored in the publication of Chittenden, Long and Herter, as if it had never existed! From this it may be concluded at once that the results or conclusions of Wiley did not seem, to the second commission, worth discussing. This is so much the more surprising in that Wiley, under the authority of the Department of Agriculture, has, for years, been publishing similar investigations on boric acid, salicylic acid, etc. Under these circumstances I had at first thought of leaving Wiley's work entirely out of consideration, but since Dr. V. Gerlach, of Wiesbaden, in the third* of the detailed publications mentioned above, expresses his regret that he had access to only a short abstract of Wiley's investigation, a discussion of the original, which now lies before me, will be appropriate, especially as the work will become even more difficultly accessible in the future.

Wiley studied the effect of benzoic acid on six persons and that of sodium benzoate on six others. In each case a 10-day period without the preservative was followed by a 5-day period with 1 gram, then by periods of equal length with 1.5, 2.0 and 2.5 grams, each, of the preservative, and finally by another 10-day period without the preservative; *i. e.*, 40 days, in 20 of which benzoic acid was administered. Above all, it is to be regretted that the preparations were given in capsules and that the small quantities (0.25–0.5 gram) which, in practise, are most important were not administered, as the minimal dose was 1 gram; and finally, that the experiments were extended only over a relatively short time. As far as concerns the results, I cling to the good custom of not doubting an investigator's facts and analytical data; only the basis and logic of the conclusions are here discussed. From the experiments, which are reported carefully and in considerable detail in 250 pages, Wiley concludes some very disadvantageous things for benzoic acid. He finds:

It is evident that the use of benzoic acid, either as such or in the form of sodium benzoate, is

“*Physiologische Wirkungen der Benzoesäure und des benzoesauren Natrons*,” Verlag von H. Staadt, Wiesbaden, 1909.

highly objectionable and that it produces grave disturbances of the metabolism and health (irritation of the stomach, nausea, headache and, in a few cases, vomiting). So much the more importance is placed on these symptoms as they were observed in healthy men, well and carefully fed. All the test persons showed a distinct loss in weight and all the more or less marked changes in metabolism shown by investigation of the urine and feces were always of such a nature that they could never be regarded as a favorable change.

In my opinion, this sentence might just as well read: Careful investigation of the urine, feces and metabolism did not shew a single symptom from which a disturbance due to the partaking of benzoic acid might be deduced! That the normal condition could not be improved by benzoic acid, as Wiley seems to require, is not surprising. As Wiley is thus far the only investigator who, supported by comprehensive experiments, has formed a condemnatory opinion of benzoic acid on toxicological grounds, I have taken the trouble to criticize his work somewhat more closely and to examine the value of his arguments. The very thorough examination of the urine, which is reported in many tables, showed nothing special. Who could lay much value on the fact that in the benzoic-acid periods the amount of solid substances in the urine increases 2.3 grams, *i. e.*, from 55.5 to 57.8, when, in the first place, the diet is not strictly fixed and, secondly, the addition of 1–2 grams of benzoic acid per day almost completely covers the increase. The relation of sulphur to nitrogen, sulphuric acid to nitrogen and phosphoric acid to nitrogen remained entirely unchanged; with the arbitrary diet the variations of 1–3 per cent., either way, of the values are unavoidable. The alkylsulphuric acids remained perfectly constant, the absolute amount of urinary sulphur changed only to an insignificant degree explainable by the method of procedure; a decrease of neutral sulphur from 14 to 12.4 per cent. in the benzoic acid period and to 11.1 per cent. in the after period seems to be proved, while on the other hand the total sulphur shows an increase from 85.9 to 87.7 and 88.9 per cent. But any one wanting to

draw any conclusions from this might just as well, instead of supposing, like Wiley, an increase of oxidation, infer that the oxidizing power of the body is distinctly increased a little by rather large doses of benzoic acid and increases still more after the excretion of the benzoic acid, a sign of an especially powerful cell activity. It is an interesting fact that the separation of benzoic acid as hippuric acid does not take place very quickly but that an after period following a rather prolonged benzoic acid diet still shows increased hippuric acid. The microscopic investigation of the urine—the method is not described in detail—was made six times in all for each of the twelve persons studied—once each in the fore and after periods and four times in the benzoic acid periods. The results are represented by numbers: 0=nothing, 1=very little, 2=little, 3=considerable, 4=much, 5=very much. The following substances were sought for: crystals of uric acid, oxalates and phosphates, amorphous phosphates, epithelial cells and leucocytes, hyaline cylinders, finely granulated and coarsely granulated cylinders, mucous cylinders, mucous fibers. The numbers were added for the twelve persons and divided by twelve, and the values so obtained compared in percentages! According to the mean values most of the organized elements are increased somewhat; leaving out the crystals, the leucocytes and the finely and coarsely granulated cylinders are somewhat increased, the hyaline cylinders somewhat diminished and the mucous fibers hardly appreciably increased. Considering how strongly a 2 influences the 1's and 0's which are found in greater number, it is preferable to consider more closely each individual constituent of the six series. When this is done it is found that, excepting the mucous cylinders (increase of 50 per cent.), nothing at all remains of all the construed increases. But as the mucous fibers do not markedly increase, I set no importance on the increase of the mucous cylinders. Wiley, however, concludes that there is a slight tendency towards an increase of renal activity during the benzoic acid periods. This "slight tendency" to

cause everything that is possibly bad is construed everywhere that Wiley can say nothing definite. In the feces nothing remarkable was found. On an average, in the experiments with benzoic acid the feces were a trifle drier, in the benzoate experiments somewhat damper, during and after the administration of the preservative than before it was given.

That the majority of Wiley's twelve persons should have lost 0.5–2.0 kilograms on a freely chosen diet is very remarkable, and we should much like to learn more as to the principles on which the amount of food was measured. The amounts of dry substance, fat, nitrogen and calories daily taken in the individual periods vary not inconsiderably—with a "faint tendency" in most cases to decrease in the course of the forty days—which alone explains the slight decreases in weight. We do not learn why a greater regularity in the taking of food was not striven for. I reproduce some particulars concerning one person: Test Person 1 (C. W. N.) had nothing particular to complain of against benzoic acid, but found that his strength decreased markedly, so that he could hardly do his work. At the same time, however, it is stated that this person was often very hungry, that the abundant and varied food with 4,000 calories was not sufficient for him. On the other hand, it is seen from page 1090 that during the fore period this person partook of 606 grams of dry food, on the average during the total benzoic acid periods, of 590 grams, and in the after period, of only 567 grams. Why more food was not given him remains incomprehensible, as he had already decreased 0.5 kilogram in weight in the second 5-day fore period and 0.3 kilogram in the first 5-day benzoic acid period and was hungry! In this record I see nothing but decreased body weight and consequent feeling of weakness, probably increased by suggestion, resulting from a somewhat too limited consumption of food. To other persons was given 1 per cent. of the body weight in dry substance, to No. 1 only 0.87 per cent. On page 1166 we learn, to our surprise, that Person 1, who daily took about 13–14 grams of nitrogen; daily gained

(in spite of decrease in weight) 0.53 gram nitrogen in the fore period, 0.39 gram in the benzoic acid period and 1.41 grams in the after period, and therefore apparently became poorer in fat and richer in albumin. And we learn further that Person 1 did not at all stand alone in this respect. In spite of decreases in weight and disturbances of metabolism of subjective nature, five of the twelve persons increased, seven decreased, in nitrogen; in the average of all twelve experiments there was even, in all the periods and sub-periods of the 40-day test, a daily increase of 1.2–1.5 grams of nitrogen. The nitrogen was used to the best advantage; on an average for all the test persons, 7.26 per cent. was excreted in the feces in the fore period, 7.44 in the benzoic acid period and 8.16 in the after period. The phosphoric acid metabolism was hardly influenced, but it is true, as Wiley brings out, that during the benzoic acid period the phosphoric acid increases a trifle (about 3 per cent.) in the feces and decreases by about the same amount in the urine; in the after period the increase in the feces and the decrease in the urine were somewhat more marked. Wiley draws no conclusions from this. This might be considered as a poorer utilization of the phosphorus of the food, but greater guarantee as to the amount and nature of combination of the phosphorus compounds given would be necessary. That the number of blood corpuscles would also show variations was clear. Their number was greatly raised, as compared with the fore period, after 2 administrations of benzoic acid; considerably decreased, as compared with the fore period, after 3 administrations; was about the same as in the fore period after 1 administration; increased after 3 doses of sodium benzoate; decreased after 2 doses; not determined after 1 dose.

The general average for all twelve persons was as follows:

	Red Corpuscles	White Corpuscles	Hemo- globin Per Cent.
Fore period	5,082,273	7,433	96
Benzoic acid period	5,099,583	7,331	96
After period	5,255,000	6,644	97

No conclusion, therefore, for or against benzoic acid can be drawn from these data, yet Wiley speaks of a "tendency" to diminish the red corpuscles which benzoic acid seems to have!

In my honest opinion, Wiley's publication is lacking in every proof, every objective proof, of the harmfulness of benzoic acid, and from the voluminous metabolism investigations which Wiley has so pitilessly used against benzoic acid exactly the opposite conclusion may be drawn, that, at most, each and every entirely subordinate fact (I have carefully reproduced them all above from Wiley's publication) remains somewhat doubtful in its significance. From Wiley's report on subjective symptoms of digestive disturbances by 1–2 gram quantities of benzoic acid in wafers, no conclusions can be drawn; even with this method of procedure, so ill-adapted to our problem, the data stand too isolated in the literature. They give the impression that suggestion played a considerable part in them, for there is no doubt that in Wiley's laboratory preservatives are considered with extreme mistrust and antipathy and that the test persons should imbibe some of this antipathy is easily conceivable. I surmise that this was also the general impression of the American authorities and that new investigations by Chittenden, Long and Herter were instituted to critically test Wiley's results, which were contrary to all observations so far made in the laboratory and in practise.

Although the volume of analyses and observations reported by Wiley and their evident cost are considerable, the extent of the work of the other investigators is surprising. This voluminousness of the work, especially the numberless tables, makes it difficult to enter very much into the details of it. Moreover, it is really a question of three independent pieces of work. The three gentlemen, entirely independently of each other but following a carefully preconceived plan, each subjected 6, 6 and 4 young physicians and chemists, respectively, to metabolism investi-

gations lasting not less than four months. There were thus $16 \times 120 = 1,920$ test days. On 40 of the 120 days, *i. e.*, on 640 days, exact urinary analyses were made. The benzoic acid was given in the following manner: In a fore period of 10 days no benzoic acid was given, then for two months 0.3 gram was given daily, then none for 5 days, 0.6 gram for 7 days, 1 gram for 7 days, 2 grams for 7 days, 4, 6 and 10 grams, respectively, for 7 days, and finally for 10 days no benzoic acid was given (the individual experimenters worked a little differently); the benzoic acid was mixed with the food and given as sodium benzoate. It must also be pointed out that the test persons were not exclusively of especially robust health; in fact, some of rather moderate constitution were taken.

In the first pages of the work is given, briefly, clearly and concisely, what interests us most, the conclusions of the three investigators.

Sodium benzoate in small doses, less than 0.5 gram mixed with the food, is without toxic effect and does not disturb health. Sodium benzoate in large doses, up to 4 grams mixed with the food, showed, upon investigation, no harmful effect in the general sense of the word. In some directions were observed small changes in certain physiological processes, the exact significance of which changes is not known.

According to the investigations, the mixing of sodium benzoate in smaller or larger doses has no unfavorable or deteriorating influence on the value of such food. In this series of experiments, also, the test persons were not in exact nitrogen equilibrium. They were allowed to enjoy at will, within certain limits, quite complicated, extremely varied and dainty foods, the food being merely weighed and analyzed. The daily consumption of food, which, in Germany in such experiments, we keep as nearly as possible uniform in nature and equal in amount, varied not inconsiderably, even though it must be confessed that the daily consumption of food by this method was relatively uniform. We can, therefore, without more evidence, just as easily draw favorable conclusions for

benzoic acid from the slight increases in weight which almost all of these well-fed test persons showed as unfavorable ones from the opposite facts in the Wiley experiments. It only shows that benzoic acid is not grossly harmful. Exact metabolism observations in the absolute sense are, also, impossible; only relative values can be discussed exactly, and here, too, the so widely varying nutrition is a somewhat disturbing factor.

The utilization of dry substance, fat and albumin, as we are accustomed to observe it in Germany, is not ascertained here. But I have convinced myself, from a series of values which I have calculated, that no influences on the utilization are to be observed. The corpuscular elements in the urine were not, contrary to the observations of Wiley, increased. No general symptoms were noted, either with the smaller or the larger doses. Of the numberless details of the three investigations we can safely say that, like Wiley's, they show that in almost all special cases nothing essential is changed by the administration of benzoic acid; I may therefore confine myself to picking out a few points. Chittenden expresses, at the end, his extraordinarily favorable opinion that sodium benzoate, up to a dose of 4 grams daily, is no more disturbing or harmful to the human organism than the same quantities of salt. He makes no reservation in any direction, draws no suspicious conclusions from his observations, not even from the establishment, by Wiley's results, that the excretion of benzoic acid as hippuric acid in the urine is somewhat retarded. Long obtains very favorable results; he did, indeed, observe in his uneducated test persons (institute help, etc.) a slight disturbance at times (headache, vomiting, disturbance of sight, excitement) but always found a plausible explanation for it and never feels forced to ascribe it to benzoic acid. Herter noticed, especially with large doses, a slight increase of indican in the urine, but no change in the alkylsulphuric acid, a decrease of the fecal bacteria which evolve gases and an increase of the cocci as compared with other bacteria in

the feces. All these facts find a natural explanation in a somewhat decreased carbohydrate fermentation in the feces and somewhat increased scission of albumen, owing to certain bacteria or bacterial functions being favored by the benzoic acid at the expense of others; no one will interpret this as being hygienically dubious. Herter's values (p. 747) show very prettily the smooth transformation of benzoic acid into hippuric acid; according to his experiments, there is no appreciable retardation. A striking fact in all four of Herter's test persons was the increase of free hydrochloric acid in the expressed gastric juice during large benzoate doses, which could easily be considered as a symptom of irritation of the stomach, but is also capable of other explanations. Gerlach's experiments (see below) showed nothing of this in man or animal. There are many other details in this voluminous book, but they are hardly of significance for the problem and I have tried to bring out anything that might be disadvantageous for benzoic acid.

Most perspicuous to us Germans is the investigation carried out by Dr. Gerlach, of Wiesbaden, by German physiologico-pharmaceutical methods and which, though far behind the American works in scope and extent, can be the more easily surveyed as a whole. Small, medium and large doses were tested on animals and men. I shall not enter into the details of the experiments with rabbits, which were able to take very large doses of benzoic acid without any effects. One gram of benzoic acid was borne subcutaneously by a rabbit for 12 days without harm; a dog was fed with 7.5 grams of sodium benzoate in one dose without disturbing effects; in experiments on the investigator himself, 10 grams of benzoic acid, taken within 3 hours, had no influence on the pulse, respiration, body temperature, digestion and general well-being. (Not every stomach can stand such a dose!—Abstractor.) Two persons daily took 0.5 and 1 gram of benzoic acid and sodium benzoate, respectively, for 80–90 days without any effect. The most careful observation showed

no special disturbances of the respiration, pulse or body temperature after taking 1 and 2 grams of benzoic acid and sodium benzoate, respectively. The action of the digestive ferments, gastric juice, trypsin and the diastatic ferments was not influenced by benzoic acid and sodium benzoate. Three and five grams of benzoic acid and sodium benzoate had no influence on the quantity, acid content and digestive power of the gastric juice of a dog subjected to the Pawlow operation. Half a gram and one gram of benzoic acid and sodium benzoate, respectively, taken by the experimenter at a test breakfast, exerted no influence on the free hydrochloric acid, total acidity and digestive power of the gastric juice, collected one hour after the breakfast. In metabolism experiments on men, it was found that 1 gram benzoic acid or 1.5 grams sodium benzoate (each taken 6 successive days) had no effect whatever on the stock of albumin in the body nor on the utilization of the nitrogenous substance and fat in the food. Eighty-two doses of 1 gram each of benzoic acid, taken within 86 days, and 88 doses, taken within 92 days, showed no unfavorable effects on the general well-being, body weight, etc. At the end of the experiments, it was found that the benzoic acid, whether mixed foods or chiefly vegetables were eaten, was completely transformed into hippuric acid. Gerlach collects from the literature a large number of cases, not all of which are contained in my earlier review, and which show that large doses of benzoic acid can be taken by healthy and by sick people without harm, and he concludes with the words:

Neither the observations made in medical practice and reported in the literature nor the large number of experiments which have been carried out for the purpose seem to justify the assertion that benzoic acid and sodium benzoate in small quantities, such as they are eaten in preserved foods, are able to produce any harm whatever. The attempt to prohibit the use of benzoic acid and benzoates as a preservative would therefore not be warranted by the very copious scientific material at hand.

While the American investigators and Gerlach thus reach conclusions which could not be more favorable to those who espouse the cause of benzoic acid, the question as to the admissibility of its use is not yet wholly cleared up in Europe, especially in Germany, and an unfriendly disposition predominates. France summarily prohibited the use of benzoic acid as early as 1888, long, therefore, before its thorough investigation; in Austria, also, it was excluded from use by a decision of the chief of the Board of Health on the 16th of December, 1899, and recently again he has refused his sanction.⁶ The Landesmedizinalkollegium of Saxony has likewise refused to authorize its use.⁹

In Germany the law takes no firm stand against benzoic acid. The acquittal of dealers who introduced margarine preserved with benzoic acid into the trade in Saxony is interesting. The produce dealer Gertrud Eberlein, née Herber, who had been fined 2 Marks for dealing in margarine with 0.05 per cent. benzoic acid, had started a long trial in three courts which, however, had ended with her acquittal in the assessors's, district and provincial courts. Injury to health by such doses of benzoic acid no one could maintain; the opponents of benzoic acid among the judges asserted that benzoic acid is really a preservative, that the addition of benzoic acid makes it possible to store margarine, but that the public demands fresh margarine and that the stored product is not as good as the fresh margarine. The arguments frequently made by the judges in favor of acquittal were the following: Benzoic acid has thus far not been prohibited in Germany; it occurs in cowberries in considerable quantities; in the amounts in question it is harmless; the nutritive value, wholesomeness and usefulness of the margarine is not changed; it is therefore a preservative which, where applicable, offers great advantages long sought for, without any disadvantages. The following judicial verdicts concerning benzoic acid in margarine have come to my knowledge:

⁶ *Das österr. Sanitätsw.*, 1910, Nos. 13-15.

⁹ *Jahresb. Medizinalw. Königreichs Sachsen*, 1905, 193.

- (1) Acquittal of the manufacturer F. A. Isserstedt, Elberfeld, before the assessor's court of Solingen on November 11, 1908.⁷
- (2) Acquittal of the manufacturer Held, Schkeuditz, before the assessor's court of Schkeuditz.⁸
- (3) Acquittal of the same before the provincial court of Halle. Appellate proceedings on May 3, 1910.⁹
- (4) Acquittal of the merchant G. Eberlein before the assessor's court of Dresden in June, 1910.¹⁰
- (5) Acquittal of the same before the district court of Dresden on February 8, 1911.¹¹
- (6) Acquittal of the same before the provincial court at Dresden on June 7, 1911.¹²

The following express themselves in favor of the use of benzoic acid (for margarine): (1) Professor Eccles in his book, "Die Bedeutung der Konservierungsmittel für die menschliche Ernährung in wirtschaftlicher und hygienischer Hinsicht"; (2) von Vietinghoff-Scheel;¹³ (3) Gustav Heffter;¹⁴ (4) the food chemist, Dr. Langfurth, Altona;¹⁵ (5) the food chemist, Dr. Postler, Mühlhausen;¹⁶ (6) Professor Klostermann, Halle; (7) the food chemist, Dr. Niederhäuser, Wiesbaden;¹⁷ (8) the food chemist, Dr. Lührig, Breslau;¹⁸ Professor Frerichs, Bonn.

Recently the Prussian Committee on Medical Affairs has expressed itself, in a decidedly surprising manner, in favor of the prohibition of benzoic acid as a preservative for human foodstuffs and luxuries. The referees, Privy Councillors Heffter and Abel,¹⁹ frankly acknowledge, indeed, the conclusiveness of the

⁷ *Z. Marg.-Ind.*, 1903, 69.

⁸ *Ibid.*, 1910, 113.

⁹ *Z. Marg.-Ind.*, 1910, 113.

¹⁰ *Ibid.*, 1910, 152.

¹¹ *Ibid.*, 1911, 69.

¹² *Ibid.*, 1911, 159.

¹³ *Chem. Ztg.*, 1909, 181; 1910, 904.

¹⁴ "Technologie der Fette und Öle," Vol. 3, p. 192.

¹⁵ *Z. Marg.-Ind.*, 1910, 152.

¹⁶ *Ibid.*, 1911, 69; cf. also *Chem. Ztg.*, 1911, 28, 53.

¹⁷ "Die Verwendung von Benzoesäure und ihren Salzen zur Konservierung von Nahrungsmitteln," *Vierteljahrsschrift ger. Med. u. öff. Sanitätswesen*, 41, 330 (1911).

proof afforded by the investigations of Chittenden, Long and Herter that small amounts up to 0.5 gram are harmless to the human body, but they continue:

Whether larger amounts (quantities of several grams) could, in the long run, be borne equally without effect by everybody can not as yet be answered with certainty. The experiments of the American scientists in this connection are of too limited extent and suffer from certain limitations so that they can not be considered as proof of universal harmlessness.

With these carefully worded sentences we can, on the whole, agree without, however, drawing the conclusion therefrom that benzoic acid as a preservative is to be prohibited. For, first of all, we must consider that there are many food constituents which, under such a system, we might mistrust and likewise prohibit. I might mention hops in beer, sugar in preserves and salt in salt meat. There are, beyond doubt, many of whom it can be said with certainty that not only the repeated consumption of such things, but even a single meal off of them, is prejudicial to their health. Those suffering from urethral diseases can not stand hops, diabetes patients and persons with stomach troubles can not stand preserves, kidney sufferers can not stand salt, yet such sufferers are continually eating these things, consciously or unconsciously, without any one prohibiting them to the world. Secondly, from what has been said above it is evident that benzoic acid, considering its preservative action on acid substances poor in albumin (for others it does not come into consideration), is remarkably harmless to the healthy and the sick—with no other preservative have such daring experiments been performed on sick persons without harm. If a healthy or a sick person were given just once ten times the amount of tobacco, alcohol or even of sugar that is usually taken rationally, the results would be far worse than when, instead of 0.1 to 0.5 gram benzoic acid, 1–5 grams are given. I offered this same argument, with equal justification, many years ago to those who persisted in considering saccharin as a poison.

Thirdly, no one has thus far asked more

than that it be considered whether certain special food products might not, under proper declaration, be treated with small quantities of benzoic acid. No one, except perhaps a few manufacturers, has ever dreamed simply of a permission to add benzoic acid to foods. On the contrary, there can not be much doubt that for meat and meat preparations benzoic acid and benzoates should be prohibited; they have little preservative power and when mixed with other substances (phosphates) they help to preserve a fresh color, while the decomposition goes on; like the sulphites, therefore, they give a deceptive appearance of better condition, and according to the Heffter-Abel decision even a slight odor of putrefaction of minced meat is masked or removed by the admixture of 0.25 per cent. of benzoic acid or benzoates. No one will demand the free use of benzoic acid for tinned vegetable preserves; in these cases nothing but heat is necessary. The question is whether its use for preserving egg yolks, tomatoes, lemon juice and similar preparations, as well as margarine (and this is at present the most important), can be permitted. The first-named preparations, egg yolks, tomatoes, lemon juice, are of subordinate interest as regards public nutrition and can be passed without further discussion; even the most timid would not need to fear gravely for the public health if benzoic acid in such preparations were allowed, a statement as to the amount used being required. Personally, I am unconditionally in its favor when it is proved that these products can be prepared in a non-perishable form and kept without preservatives only with great difficulty or not at all.

The question as to allowing the use of benzoic acid in margarine, which has become a real public foodstuff, demands special treatment. One hundred and fifty million kilograms of margarine are said to be produced annually in Germany and a considerable part of it used in this country.¹⁸ It would be very difficult today, especially for those living in cities, to protect themselves against margarine in their food. Any one in a hotel or purchasing fatty

¹⁸ *Z. Marg.-Ind.*, 1910, 134.

confectionery or bakery wares will at once make the acquaintance of margarine; only the preparation of all food in one's own house insures safety. Margarine has won this position in spite of all compulsory declarations, in spite of the foreign-sounding name, because it fills the need of the people for a cheap fat. Leaving out one recent case where the criminal negligence of a firm in carelessly selling a poisonous foreign fat caused many cases of illness and some deaths, so far there has not been much with which margarine can be reproached.

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SCIENTIFIC BOOKS

Planktonkunde. Von Dr. ADOLF STEUER. Leipzig und Berlin, Teubner. 1910. Pp. xv + 723. Mit 365 Abbildungen im Text und 1 Tafel.

Leitfaden der Planktonkunde. Von Dr. ADOLF STEUER. Leipzig und Berlin, Teubner. Pp. 382. Mit 279 Abbildungen im Text und 1 Tafel. M. 7. Geb. M. 8.

Many additions have been made to our knowledge of the floating life of the sea and its counterpart in fresh water, the plankton, since Haeckel published his highly theoretical "Plankton-Studien" with its elaborate but never generally adopted nomenclature and classification of this domain of life. The work of the Kiel school and its Plankton Expedition and Henson's Danaid task of taking a census of the sea, the *Valdivia* expedition with its superbly illustrated reports, the various expeditions of the Prince of Monaco, of the U. S. Steamer *Albatross* under the direction of the late Alexander Agassiz, the work of the International Commission for the Investigation of the Sea and the investigations of the fresh-water stations in Denmark, Germany, Switzerland and the United States have resulted in the perfection of instruments and methods and the accumulation of a mass of results. Steuer's treatise on planktonology thus finds the time opportune for appearance and fittingly forms a volume in the

Teubner series ("Naturwissenschaft und Technik in Lehre und Forschung") under the editorship of Professors Doflein and Fischer, of Munich.

The first work is comprehensive in plan, covering all phases of the varied content of the subject of the life of the sea and of fresh water. The first chapter of the work deals with water, its distribution on the earth, chemical constituents, temperature changes, its relations to light and pressure, its color and odor, and its movements under meteorological influences. Other chapters treat of methods, quantitative, qualitative and statistical, of plankton investigations, of the adaptations of the plankton to flotation with special reference to viscosity in relation to temperature and season, of adaptations in color, and of phosphorescence.

It appears that the data cited by Steuer are quite inadequate to establish his thesis that the organisms of the plankton as compared with those of the bottom and shore are characterized by a relatively low rate of reproduction. It is not the pelagic nature of the organism which is the cause of the low rate of reproduction often observed in plankton-poor lakes but rather a poverty stricken habitat. The herring fisheries, the chalk beds of past ages, the abundant and rapidly fluctuating plankton of enriched rivers, the occasional sudden outbursts of the "mare sporco," all bear indisputable evidence of the capacity of pelagic life to respond to opportunities for rapid multiplication. This erroneous idea that the plankton has a relatively slight capacity for reproduction is correlated with another all too widely applied idea, namely, that the tropical seas are relatively barren. The facts are that fresh waters and the sea vary greatly in different regions and at different seasons in the amount of life they contain. In warm waters the chemical processes of life are so accelerated that life cycles are shortened and decay is hastened, while in colder waters growth and decay are slower and individuals accumulate though the total product in the two regions in a given time may be the same. Food supply and temperature affect

the rate and amount of reproduction in water as they do upon land.

The question of the biological stratification of the haliplankton is treated at length. Investigation has shown that the marine phytoplankton is mainly limited to a relatively thin superficial region about 200 m. in thickness and that it ceases to grow below 400 m. The zooplankton on the other hand descends, in the opinion of many investigators, to greater depths, feeding upon the debris of the phytoplankton and upon cadavers, descending from the more densely populated zone above. The *Valdivia*, which made but few hauls at great distances from continental influence or away from great currents, found evidence in closing net catches of animal life extending to great depths.

Steuer's presentation of Agassiz's results and conclusions in this contested matter is far from adequate. He designates the Pacific as "sehr planktonarme" and "wenig günstig" for the examination of this question of the extent of life below 400 fathoms. The plankton of the Pacific is certainly as rich in large areas and probably no poorer in others than that of other oceans, while the oceanic conditions it presents for investigation could hardly be more typical or more favorable for the determination of this question. Nor is Steuer's statement that Agassiz's admission of the existence of a true bathybiotic plankton is to be accepted as placing him in accord with his opponents, to be regarded as either adequate or critical, for Agassiz limited this bathybiotic plankton to regions of continental influence and to territories below richly laden currents. Furthermore, to characterize Agassiz's discoveries of so-called deep sea animals, such as *Pelagotheria* and fishes as "gelegentliche Auftretungen" of the bathybiotic fauna in the upper levels of the sea is to dismiss a mass of evidence with a wave of the hand.

The horizontal divisions and the geographical and seasonal distribution of the plankton are discussed at length and its relation to the economy of nature and to man are analyzed. Under the latter caption attention is called to the relation of those occasional outbursts of

species resulting in discolored seas and disturbances in the balance of nature, to plankton as a source of food for man and for fishes, to pond culture, to purification of polluted streams, to fish culture, to plankton as an index of productive capacity of water, and to the relations of plankton organisms to education, research and the fine arts.

A compiled work of this sort, the first in its field, is necessarily incomplete and imperfect. Noticeable omissions in both works are the Lucas sounding machine, Whipple's thermometer, Nathanson's discussion of the relation of vertical circulation to the problem of maintenance of fertility of the sea, Petterssen's, Ekman's and Nansen's contributions to facts and theories of oceanic circulation, Bauer's work on vertical migrations, and, in general, an occasional lack of perspective in dealing with the results of Scandinavian, English, French and American literature of the subject—defects easily remedied in a new edition. Dr. Steuer has done a great service in putting in so concise and compact a form the most striking and many noteworthy achievements in the field of planktology. The illustrations are numerous, usually good and well-executed. Exception may be taken to inverted figures of *Ceratium* (p. 476) and to an inverted figure from Okamura of a crushed Peridinium labelled *Gonyaulax polygramma*. Much better figures of this species have long been available.

The second work is an abridgment of the first, omitting some of the illustrations, the extensive bibliographies and some of the more technical treatment of the chemistry and physics of water and some of the details of the discussion of the seasonal distribution of the plankton.

CHARLES ATWOOD KOFOD

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The Realm of Ends or Pluralism and Theism: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1907-1910. By JAMES WARD, Sc.D. (Camb.), etc., Fellow of the British Academy and of the New York Academy of Sciences, Professor

of Mental Philosophy, Cambridge. New York, G. P. Putnam's Sons. 1911. 8vo. Pp. xv + 490. Price, \$3.00 net.

It was inevitable that the Gifford foundation for "natural theology" in the four Scots universities should produce some notable books, one or two bad books, and non-significant books not a few. Professor Ward's Aberdeen lectures of 1896-98, published under the title, "Naturalism and Agnosticism," have taken rank in the first class long since, as three editions attest. They embody a criticism of the Spencerian type of thinking, so astute and resourceful that, possibly, the assault need never be undertaken again. The present lectures are no less important, but, unlike their predecessors, they travel far from the beaten track of the "positive" sciences. It is the more necessary, then, to describe their contents fairly for readers of SCIENCE.

In the decade that has elapsed between the two courses, the fortunes of the "mechanical theory" have tended to sink lower and lower, so much so, that the spirit of revolt against it may be said to dominate contemporary philosophy, particularly in France, and this with scarce a protest, certainly with no effective protest, from the scientific camp; nay, if anything, with approval—witness McDougall's recent "Body and Mind." But, if the "mechanical theory" be thus relegated to the limbo of discards, we are confronted forthwith by a new situation. We must try "to ascertain what we can know, or reasonably believe, concerning the constitution of the world, interpreted throughout and strictly in terms of Mind" (p. v). Professor Ward's new work is a candid attempt to face this problem, and to think it through. Accordingly, its plan and main contents are as follows:

Part I. is a most adequate discussion of pluralism. After two introductory lectures (I., II.) and a discourse on the fundamental nature and contemporary ascendancy of this theory (III.), the author analyzes contingency in the world (IV.), evolution (V.) and the pluralistic goal (VI.). He then devotes two lectures (VII., VIII.) to Hegel—"it must be confessed, largely a digression" (p. vi). Part I. ends with critical treatment of the limits

and difficulties of pluralism (IX., X.), whence Part II., Theism, originates. "For pluralism, though empirically warranted, we find defective and unsatisfactory; but the theism to which it points is only an ideal—an ideal, however, that, as both theoretically and practically rational, may claim our faith though it transcend our knowledge" (pp. v, vi). Here Professor Ward plunges *in medias res* at once, with discussion of the idea of creation (XI.), and of the cosmology of theism (XII.). Investigations of freedom and foreknowledge (XIII., XIV.) follow. Lectures XV.-XVII. deal with the problem of evil in its relations to pessimism, optimism and the moral order. Lecture XVIII. presents theories of a future life and, as a pendant, we have a chapter on faith and knowledge (XIX.). The concluding lecture, the Realm of Ends, is in the nature of a summary, and may be read as an introduction to the book. Twenty-seven pages of supplementary notes (on contingency, creation, the relation of body and mind, the temporal and the eternal, and the divine experience), and an adequate index, complete the volume.

In view of the subjects discussed, it is well, perhaps, to add by way of elucidation, if not warning, that Professor Ward has always kept in view the condition laid down by the founder. Lord Gifford's will contains this direction:

I wish the lecturers to treat their subject as a strictly natural science, . . . without reference to or reliance upon any supposed special or exceptional or so-called miraculous revelation. . . . They may freely discuss all questions about man's conceptions of God or the Infinite, their origin, nature, and truth, whether he can have any such conceptions, whether God is under any or what limitations, and so on.

This is precisely what Professor Ward has done; and, to quote the words of the first lecturer on the foundation, Max Müller, the book "must be reckoned among the signs of the times, pregnant with meaning." For it is the latest pronouncement, not simply of a veteran, but of one of the ripest and, from the scientific point of view, best equipped, among living thinkers.

Taking the work as a whole—for space forbids detail—the following remarks and excerpts may help to indicate its attitude and quality. Dr. Ward adopts the pluralistic position in pragmatic fashion. He insists that, as a matter of fact, we do start from a plurality of existing things. On the other hand, he nowhere affirms these things to be self-subsisting and, to this extent, leaves a convenient loophole. The most interesting result, from the scientific standpoint, is, possibly, the interpretation of evolution. "It is often applied to processes that are diametrically opposed, to the differentiation of a unity and to the integration of a plurality (97). . . . To the supposed unfolding of an organism regarded as completely pre-existing in miniature within the germ. . . . The successive unfolding of such a system, . . . though the *ne plus ultra* of evolution literally understood is then the direct negative of evolution as we understand it to-day. According to this later theory each new organism is not an 'educt,' but a 'product,' to use Kantian phrases: its *parts* are in no sense present in the embryo, but are gradually organized, one after another, in due order, as the term epigenesis implies and as Harvey, who first used the term, prophetically maintained (98). . . . It is the parts, the many, with which the pluralist starts: the question, whether or no there is an absolute whole prior to—at once the logical and the real ground of—all the parts, is for him not the first question but the last" (101). Plainly, the pluralist is tied to epigenesis: "The life-history of the race is original, is a long process of gradual acquisition by way of trial and error, in short, answers to what we have identified with *natura naturans*; whereas the genetic history of the individual is a derivative, rapid and, so to say, substantially invariable process, in a word, is routine or *natura naturata*" (207). Yet, even so, pluralism has its own difficulties. An "absolute plurality" "would be merely a sporadic manifold of realms of ends having a common physical basis but devoid of all teleological continuity (185). . . . A Supreme Spirit con-

fronted and conditioned by free agents certainly does not correspond to the notion usually entertained of the Deity. Such a 'finite God' many would disown as a manifest contradiction in terms; yet beyond this it does not seem possible for the pluralist to go" (194). Nevertheless, pluralists would deny that evolution requires a transcendent Prime Mover distinct from the Many: for the Many they hold are all prime movers, and so far *causæ sui*. . . . The efficient causation in the world then is just this totality of prime movers, its final causation their organization into a higher unity" (199). That is to say, singularism, with its Absolute, is not the sole alternative; nor is scepticism the consequent recourse; therefore the contradictions as between the One and the Many remain to be overcome. The lectures on Theism offer the solution, or considerations towards it.

Theism "introduces one essential modification, at any rate, viz., the idea of creation. It does not, that is to say, assume merely that one transcendent Being exists above and beyond the whole series of the Many, however extended; but it assumes further that this one Being is related to them in a way in which none of them is related to the rest: they do not simply coexist along with it, they exist somehow in it, and through it" (231). This implies the difficulty, admitted to be insuperable (245), of the self-limitation of Deity. Hence, turning again to experience, "between the intemporal world of ideas and the temporal world of phenomena, free agents have their place" (306). Accordingly, the ideal realm of ends is "the achievement of virtuous struggle crowned eventually with victory" (374). Consequently, as to immortality and faith, "death becomes indeed but a longer sleep dividing life from life as sleep divides day from day; and as there is progress from day to day so too there may be from life to life (407). . . . Hence the moral ideal, as it leads to faith in God, leads also to the belief that the spirit world has other dimensions than those of the time and space that encompass the world of phenomena. . . . Has not God been mocked and life called the vanity of

vanities on the assumption that the present world is all?" (429).

Despite my radical dissent from Dr. Ward's pluralism, with its concessions to what I am bound to call irrationalism, his book has made a profound impression upon me. It is a work which any man may well peruse as a discipline in self-education, and this without reference to the field of his specialty. Assuredly, we have to thank Dr. Ward for a human, and therefore significant—often a wise—pronouncement. A main portion of the charm of the work is traceable to the skill shown by the author in conferring distinction upon the commonest things.

R. M. WENLEY

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BOTANICAL NOTES

THE PASSING OF THE SLIME MOULDS

DE BARY, whose keen botanical perception has perhaps never been equalled, long ago discarded the name *Myxomycetes* for the slime moulds, significantly applying to them the name *Mycetozoa*, and then placed them outside the limits of the vegetable kingdom, greatly to the consternation and indignation of many fungologists of the old school. The latter, relying upon external characters, associated them for a long time with the puffballs among the higher fungi, implying a relationship whose impossibility is now manifest to the merest tyro in botany. Latterly they have been pushed down into the neighborhood of the schizophytes (blue-green algae, and the bacteria), as is done by Engler in his "*Syllabus*," but he takes particular pains to disclaim any relationship with the true fungi (*Eumycetes*), or higher plants.

More than thirty years ago the writer of this note said of them "they have no structural affinities with plants higher than they are, nor with any lower; they stand alone, and appear to belong to a different genetic line" ("*Botany*," p. 207), although in deference to the views as to their nature then prevalent they were still included among plants. By speaking of them as "a group of remarkable organisms which differ in many respects from

all other vegetable structures," and by comparing them to certain Protozoa the attempt was made to educate the reader to regard them as aliens instead of true plants. In later publications they have been omitted as no longer necessary to be spoken of in a systematic arrangement of plants.

The final disappearance of these animals from the domain of botany seems now imminent, for in the new (eleventh) edition of the *Encyclopaedia Britannica* they are treated under De Bary's name of *Mycetozoa*, with the introductory defining phrase "in zoology, a group of organisms reproducing themselves by spores." The whole treatment, which is by J. J. Lister, is zoological, and no doubt is expressed as to their animal nature. We may now look for an approaching general revision of our botanical text-books so as to omit the *Mycetozoa*, greatly to the relief of the scientific botanists who have long been sorely puzzled to find a proper niche in which to fit them in the vegetable kingdom.

It will now be necessary for the zoologists to prepare to take charge of the considerable number of *Mycetozoa* to which they fall heir. It behooves the botanists to generously remove the specimens of these organisms from the pigeon-holes of their herbaria, and turn them over to the zoologists to be placed by them on the museum shelves devoted to the *Sarcodinia* among the Protozoa. And further it will become necessary for the librarians to revise their system of classifying botanical and zoological books so as to make the proper transfers upon their shelves and in their card catalogues. When all this is done the botanists may feel that they are well rid of these animals that have too long roamed quite too freely in the botanical garden. The "slime moulds" will have passed from the domain of botany, and there will remain in their stead only the "fungus animals."

THE SECRET OF THE BLUEBERRIES

If to make "two blades of grass grow where but one grew before" has been regarded as a laudable undertaking, what shall we say of the successful effort to make blueberries grow

where they would not grow at all, and yet this is what F. V. Coville, the government botanist, seems to have done. In an interesting bulletin (193) of the Bureau of Plant Industry of the U. S. Department of Agriculture which appeared a little more than a year ago, Mr. Coville shows that blueberries (mainly of the species *Vaccinium corymbosum*, known as the swamp blueberry) differ from many ordinary plants in their soil requirements, and with the knowledge thus attained he has worked out a system of culture that promises to result in their successful culture. In the course of his paper it is shown that the swamp blueberry "does not thrive in a rich garden soil," nor on "heavily manured soil," and so for soil treated by lime, heavy clay soil, ordinary leaf mold soil, or any soil with a neutral or alkaline reaction. On the contrary, it is shown that it requires an acid soil, such as afforded by peat.

Applying these facts, Mr. Coville has successfully grown many plants of the swamp blueberry in pots, and their robust growth affords good promise of success in the field. The investigation with pot cultures is to be followed with those in the field and in this considerable progress has been made. "There is good prospect that the application of the knowledge thus gained [from the pot cultures] will establish the blueberry in field culture, and that ultimately improved varieties of these plants will be grown successfully on a commercial scale."

THE GRAMA GRASSES

DAVID GRIFFITHS has rendered a good service to students of the grasses by the publication of his paper on "The Grama Grasses" (Contrib. U. S. Nat'l Herbarium, Vol. 14, pt. 3, 1912), in which he describes the species (46) included in the genus *Bouteloua* (36), *Cathestecum* (4), *Pentarrhaphis* (2), and *Triana* (1). By means of good figures the details of the spikelets are made plain, and these are supplemented by full descriptions, and a citation of specimens in the National Herbarium. The synonymy of these species

is given very fully with critical notes. From this portion of the paper we learn why the more common species now bear the names *Bouteloua hirsuta*, *B. gracilis* (instead of *B. oligostachya*), and *B. curtipendula* (instead of *Atheropogon curtipendula*). One new species of *Cathestecum* and two of *Bouteloua* are described.

In speaking of their economic importance the author says: "It is doubtful whether there is another group of native pasture grasses which is of as much economic importance as this when both quality and quantity are considered." "The most promising of all the species for field cultivation is *B. curtipendula*, not that it grows any more readily than the others, but on account of its size and habit." "*Bouteloua gracilis* makes a splendid turf when sown thickly and well cared for." However, on account of the difficulty in collecting seed he has to say at last that "in short, it is more than probable that because of the lack of good seed habits in this genus, even the most valuable species can not become of importance in cultivation."

BOTANICAL NOTES

A NUMBER of papers on the fungi should be noted here—the first, by W. C. Coker and Louise Wilson (in *Mycologia*, November, 1911), on a curious "conjugating yeast" (*Schizosaccharomyces octosporus*) in fermenting grapes, in which the plants multiply vegetatively not by budding, as in other yeasts, but by fission. The "conjugating" cells constitute "a double sac that resembles a pair of saddle-bags" and in this structure eight spores are produced.

The "Experiments on Spore Germination and Infection in Certain Species of Oomycetes" (Research Bull. 15, Wisconsin Experiment Station) by I. E. Melhus, are concerned with the White Rust of Crucifers (*Cystopus* (*Albugo*) *candidus*). It was found that the spores germinate best in water and rather low temperatures, and that plants are more easily infected at low temperatures, also, probably "due to the increased percentage of spore germination."

DR. RICHARD DE ZEEUW publishes a helpful paper in the *Centralblatt für Bacteriologie, Parasitenkunde und Infektionskrankheiten*, 1911, on the "Comparative Viability of Seeds, Fungi and Bacteria when Subjected to Various Chemical Agents," in which he shows that the disinfection of seeds, etc., is by no means as easily accomplished as has been supposed, and that the results of many experiments requiring disinfection are open to criticism.

We can not pass by without at least brief mention the *Journal of the College of Agriculture of the Imperial University of Tokyo* (Japan), in the December number of which are two articles by Professor Dr. S. Kusano, the first, on "*Gastrodia elata* and its Symbiotic Association with *Armillaria mellea*," showing that this chlorophyll-less orchid lives in a beneficially symbiotic relation with the mycelium of the fungus. The second paper, "On the Root-Cotton, a Fibrous Cork Tissue of a Tropical Plant" (*Fagara integrifolia*), shows that "the root-cotton is a kind of cork tissue derived from the cork cambium, which arises primarily from the pericycle or secondarily from the bast of the root." The author concludes that it is of economic value, "chiefly in its unwettable and less hygroscopic quality." The papers are illustrated by seven very fine plates.

CHARLES E. BESSEY

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THE RELATION OF PIGMENTATION TO TEMPERATURE IN DEEP-SEA ANIMALS

PROFESSOR C. V. BURKE's article on the relation of color of certain sea-animals to the depth at which they live¹ is of much more than ordinary importance, for it may be possible to coordinate these facts with similar ones as to tropical land animals which show that pigmentation is of great, if not vital importance in heat regulation. In nearly all the biological literature on the subject, it is assumed that the sole use of pigment is for concealment by

more or less resemblance to something in the background or to the background itself. This may be true of all colors but pigment of any color, if opaque enough, may protect underlying tissues from death due to excessive light, a matter to which von Schmaedgel first called attention as to man, nearly twenty years ago. This rule has now been found to be universal, for in every species there is a pigment or other protection proportionate to the intensity of the light. In the 1887 *Proceedings of the Royal Society of Edinburgh*, Dr. Robert Wallace, now professor of agriculture in the University of Edinburgh, published another epoch-making observation, which, like that of Mendel and of many others, was completely ignored for a quarter century. Wallace found that all the domestic mammals of the tropics had black skins, and though Huxley was much impressed by the universality of the phenomenon, he could suggest no reason for it because up to the time of his death very little was known as to the deadliness of the shorter ether waves to all naked living tissues, such as in the case of bacteria for instance; and though we then used sunlight to "disinfect," by killing our parasites, no one had yet perceived that it could also kill us. It is now known that the main purpose is light protection, and there is a wealth of evidence that if unpigmented stock is taken from dark climates to light ones it dies out. The agricultural experimenters have utterly failed to establish the big white swine in our west or in any light climate and at the present moment, in many parts of the world, farmers are vainly trying to breed imported stock insufficiently pigmented. The matter is of such great practical importance that it must be cleared up at once to stop the present wasteful methods.

It has also long been known that black assists heat radiation in all temperatures below body heat. These black-skinned domestic animals are then the fittest for tropical temperatures, but they can not expose themselves to the sun because of the fatal absorption of heat. They instinctively hide in the day, if the skin is not covered by a reflecting coat as in the Arab horse. In cold light countries

¹ SCIENCE, October 6, 1911.

excessive radiation is prevented by fur and hair, as in the black skinned Mongolian pony. The black skinned animals with little or no hair are therefore restricted to a very limited thermal range, while those with hair or fur protection are healthy in all extremes.

Some recent observations of horses in the Philippines, Japan and Korea have shown that slight differences in climate make great differences in hair color and it seems to depend more largely on air temperature than was formerly thought. The detailed data were published in a preliminary article in the September number of the *U. S. Cavalry Journal*, but the point of present interest is the relation of pigment to the environmental temperature.

Every kind of protoplasm has a very limited thermal range in which it functions best; in some cases there is practically no range at all for the function is disturbed by even a half degree of change. Every kind of protoplasm can live if subjected to higher or lower temperatures than its optimum even if it ceases functioning. But it is to be noted that no kind can stand very much rise of temperature, though it may be chilled to the absolute zero for a short while. The upper thermal death point is therefore so near the usual range and the malfunctioning due to any rise is so great, that each species adopts some safeguard against overheating. In the land mammals it is always some method of radiation or evaporation of perspiration and a dark color seems vital for the purpose of radiation in all temperatures below body heat. It is amazing to see the differences in horse colors in different localities according to temperature in Japan, Korea and wherever there has been no check to the process by importations for some centuries. Where there is heat to reflect at any season the color is light or white.

One of the puzzles of zoology has been to account for dense pigmentation where there is very little light. If there is complete darkness, as in some caves, the color of fishes is apt to disappear entirely by selection on the ground of economy, the pigment evidently being an expensive drain on the resources. As

fish are said to have a temperature but little above that of the water in which they live, there is evidently little or no need for them to have safeguards against overheating or chilling in a medium, never hot enough to be injurious nor below 40° F. as a rule. Hence coloration of fishes has been invariably interpreted as for concealment, and the facts certainly do point to that reason.

In the deep sea, on the other hand, we have vastly different conditions. The only light is a phosphorescence which is usually so faint as to require very large eyes, yet some investigators assure us that it can be so intense as to demand dense pigmentation for concealment. This may account for the fact that the pigment is often spread all over the body, as would be necessary if the light comes from all directions and not always from above, as in the fishes of the upper layers. Yet there are curious exceptions, as though some deep sea places were as dark as caves, for some species have little or no pigment and some have no eyes; but as far as known, the relation between these facts, if there is any relation at all, has never been explained or proved.

With regard to deep sea temperatures we are assured that generally they are very low, specimens being too cold to handle. Salt water at such pressures can be much below 32° F. without freezing, and it is often found at a degree which prevents all activity of fish in surface waters. They "hibernate" in such chilly surroundings. There must then be a different law as to the relation of the body temperature of deep sea fish to the water surrounding them. All the mammals of the sea are densely pigmented and generally all over. They are never subjected to high temperatures nor to anything lower than 32°, and have no need for protection from extremes. The pigment then must be for light protection. They all prevent undue heat loss by the thick layer of insulating fat, so the radiation of heat by the black color can do no more harm than in the case of black cattle which are found in mild temperate climates. Black pigments can not be for the purpose of absorbing heat from the sun's rays, for all such animals avoid the

sun, nor can sea-mammals absorb to any extent that way as the heat does not penetrate enough. The surrounding medium is always below body temperature and the heat flow is always from the body not into it. As all mammals seem to depend upon more or less constant loss of superfluous heat by radiation and much loss during exertion, the black colors are probably of as great use to whales and porpoises, as to elephants and similar hairless tropical animals who likewise are never exposed to extremes and whose ranges of temperature do not differ markedly from those of the sea mammals. That is, there must be, as in horses, some means of preventing overheating, and color surely helps according as the animal is shaded or exposed to the sun. The amazing differences in horses can be logically explained on these lines, as seen in the above paper. Hence there is a suspicion that dark color in all sea-fishes at any depth has some unknown relation to the temperature, as well as the need of concealment. It must be remembered that the inner surfaces of shells, and the concealed surfaces of some parts of the bodies of many animals are most unaccountably pigmented. Neither the food nor protection from light nor resemblance to the background can be the reason, nor can it be a vestige of a previous useful condition. Indeed it is a puzzle which needs explanation, and it is requested that in all future studies there be facts presented as to the temperature of both the water and the body of the animal. It is not likely that the deep-sea fish can function at such low temperatures as we are told do exist, and it is probable that we shall find that where life is abundant the temperature of both fish and water is considerably above 40° but that in the vast areas where no life at all is found the cold may be the prohibitive factor. There must be as great variation from place to place by reason of currents as in the air. The prevalent winds make only a few degrees difference between the temperature of the northeast and southwest of Japan, but the horses in the first place are dark brown and in the latter light yellow for this reason alone. There must be similar local differences

in the deep sea, due to currents to account most fully for differences in pigmentation. If the color darkens with increasing depth and coldness, then the animals surely lose by radiation what little heat they have and must be unable to function at all. Unless, then, there are different laws for the deep sea life, of which we can not conceive at present, there must be another reason for a concealing blackness which would be a fatal radiator to ancestral types nearer the surface. Indeed there may be some unknown laws of heat radiation under such tremendous pressures, which actually reverse matters and make the pigment a conservator of body heat in cold water. It can scarcely be believed that the color is to help absorption of heat, for there is little to be absorbed—the animal must depend on its own heat production. That is, the facts so far known do not explain the blackness of the deep sea fish.

CHAS. E. WOODRUFF

PHYSIOLOGICAL SEX DETERMINATION

AN interesting, if not convincing, collation of arguments in support of the notion that the suprarenal capsules are concerned in determining the sex of offspring was presented to the Paris Academy of Sciences on November 20, 1911, by Dr. R. Robinson. His arguments fall into three groups.

1. *Clinical observations.*

It has been shown by Dr. Fieux Agregi, of Bordeaux, that when the heart-beat of the fœtus is between 136 and 150 per minute there is born a female in 68 per cent. of the cases; if the heart-beat is more than 150 it is always a male. He had fifty cases. Robinson not only confirmed Agregi's observations, but was able to determine the retarding action of the administration of adrenalin upon the pulse of the fœtus. He therefore presumes that if this substance were administered from the early days of pregnancy it would influence the heart-beat and so the sex of the fœtus.

2. *Anatomo-physiological facts.*

The adrenal glands seem to influence the development of the individual after birth, if they do not cause the determination of the

sex immediately after conception; this is shown by their relations to some of the secondary sexual characters. In England a woman of 32 years who had never menstruated, had hair on face, etc., and other appearances of a man; an autopsy showed the presence of large tumor on the suprarenal. Bortz, the German surgeon, observed a girl of 16 who took on the characters of the male—beard, deep voice, distribution of hair on body, etc. Post-mortem examination showed tumor on suprarenal. A woman of 26 years was observed by a Dutch physician: she was obliged to shave like a man. Autopsy showed one of the suprarenals enclosed within the ovary. Similar facts have been published by many physicians.

3. *Chemical reactions.*

Is there any means, asks Robinson, of knowing approximately the functional state of the suprarenal capsules in the gravid female? This is worth studying if we are to come to an understanding of sex determination. Violent or obstinate vomiting and other symptoms of suprarenal insufficiency are not constant in their manifestations. He therefore used the Fränkel-Allers test (acid iodate of potassium) to reveal the slightest trace of adrenalin in the urine or blood. He used also the method of Vulpian (perchloride of iron); but found the per-iodate of potassium much more sensitive and certain in its reactions. By these means he foretold the sex of a fetus in the fourth month.

From all these facts he thinks it is safe to conclude that the adrenalin influences the sex of the developing embryo, at least in the higher vertebrates or in man.

The hypothesis that adrenalin influences the heart-beat has been subjected to experiment and has been confirmed; but the hypothesis that the rate of the heart-beat determines the sex is one that may be tested experimentally, but has not yet been so tested. It is interesting to note that in the clinical observations given by Robinson the heart-beat of the male is higher than that of the female; this is contrary to the commonly accepted relation. The argument, moreover, may prove too much. If

maleness is converted into femaleness by the adrenalin directly, or indirectly through the influence of this upon the circulatory system, it should be possible to bring on secondary female characters in a male by the administration of adrenalin before or at puberty.

The number of cases in which the sex was foretold on the basis of the Fränkel-Allers test for adrenalin in the blood or urine is not given by Robinson; presumably too few to warrant statistical conclusions. But even if the number were very large, and even if there should be found a constant relation between the sex of the fetus and the quantity of adrenalin produced in the pregnant mother, these facts would by no means indicate a causal relation in the sense assumed by Robinson. It is quite conceivable that, in the case assumed, the physiological state of the fetus determines the activity of the mother's adrenal capsules.

A more general criticism of Robinson's argument lies in the tacit assumption that sex differentiation means one thing in the higher vertebrates and man, and quite a different thing in the rest of the animal kingdom and in plants. It may well be that there are several distinct factors concerned in sex determination, but these must all belong to related categories. It is extremely improbable that sex is determined by an accessory chromosome among insects, by adrenalin among mammals, by traumatism among graminæ, say, and by ultra-violet rays among mosses. It is interesting to note, in conclusion, that physicians have formulated several theories of sex determination in recent years, but always in complete innocence of the work being done by experimental biologists along this line.

BENJ. C. GRUENBERG

COMMERCIAL HIGH SCHOOL,
BROOKLYN, N. Y.,
December 30, 1911

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and fifty-seventh regular meeting of the society was held at Columbia University on Saturday, February 24, extending through the

usual morning and afternoon sessions. The attendance included forty-one members. President H. B. Fine occupied the chair. The council announced the election of the following persons to membership in the society: Mr. J. W. Alexander, Princeton University; Mr. A. A. Bennett, Princeton University; Professor J. G. Coffin, College of the City of New York; Professor G. H. Cresce, Middlebury College; Mr. C. R. Dines, Dartmouth College; Professor H. E. Jordan, University of Kansas; Mr. F. S. Nowlan, Columbia University; Professor C. W. Watkeys, University of Rochester. Eight applications for membership in the society were received.

Announcement was made of the gift of Dr. Emory McClintock, second president of the society, of over four hundred valuable books to the library. The gift also includes a large number of pamphlets and reprints of important mathematical papers.

The following papers were read at this meeting:

S. A. Joffe: "Sums of like powers of natural numbers."

G. A. Miller: "Second note on groups generated by operators transforming each other into their inverses."

S. Lefschetz: "On remarkable points of curves."

S. E. Uerner: "Certain singularities of point transformations in space of three dimensions."

A. B. Coble: "The characteristic theory of the odd and even theta functions as related to finite geometry."

H. H. Mitchell: "Some quaternary groups with particular prime moduli."

J. E. Rowe: "The undulation and cusp invariants of the R_n ."

W. F. Osgood: "A necessary and sufficient condition that a single-valued function in a projective space be rational."

Dunham Jackson: "On the convergence of the development of a continuous function according to Legendre's polynomials."

K. P. Williams: "The solution of non-homogeneous linear difference equations and their asymptotic forms."

E. J. Miles: "Note on the isoperimetric problem with discontinuous integrand."

Dunham Jackson: "On approximation by trigonometric sums and polynomials."

J. E. Hodgson: "Orthocentric properties of the plane directed n -line."

The date of the next regular meeting of the society falls on April 27. The Chicago Section

and the San Francisco Section will both meet on April 6.

F. N. COLE,
Secretary

THE AMERICAN CHEMICAL SOCIETY NEW YORK SECTION

At the meeting held at Rumford Hall on March 8 the following sectional officers were elected to take office at the close of the present session in June: *Chairman*, Arthur B. Lamb; *Vice-chairman*, David Wesson; *Secretary-Treasurer*, C. M. Joyce; *Executive Committee*, A. C. Langmuir, G. A. Hulett, Allen Rogers and T. L. Briggs.

The Wm. H. Nichols medal (for the session of 1910-11) was awarded to Professor Charles James, of New Hampshire College, for his work on the rare earths.

Dr. W. Gilman Thompson read a paper on "Occupational Poisoning in Chemical Trades."

This paper awakened considerable interest and discussion, the meeting favoring further investigation of the subject and appointing a committee for this purpose.

Dr. A. M. Comey read a paper on "The Testing of High Explosives," illustrated by slides, and Mr. A. E. Marshall spoke on "Silica Ware: Its Manufacture, Properties and Uses."

C. M. JOYCE,
Secretary

THE NEW YORK ACADEMY OF SCIENCES SECTION OF BIOLOGY

At the regular meeting of the Section of Biology, held at the American Museum of Natural History, December 11, 1911, Chairman Frederic A. Lucas presiding, Professor Henry E. Crampton gave a lecture, illustrated with lantern slides, on his recent explorations in Guiana and Brazil. Dr. W. K. Gregory concluded his communication on the "Origin of Paired Limbs," reviewing the rival claims of the Crossopterygii and Dipnoi for the ancestry of the Amphibia and reinterpreting the elements of the pectoral limb of the Upper Devonian Rhizodont genus *Sauripterus*.

At the regular monthly meeting of the section held at the American Museum of Natural History, January 15, 1912, the following papers were read: *Phylogeny and Ontogeny of the Horns of Mammals*: HENRY FAIRFIELD OSBORN.

The recent discovery of the modes of origin of the horns in the titanotheres, a perissodactyl group remotely related to horses, tapirs and rhinoceroses, permits of a comparison of phylogenesis with the ontogenesis of the horns in bovine mammals. The

latter is based upon an osteological series recently prepared by Mr. S. H. Chubb, the former is based on the rich phylogenic series of Eocene titanotheres in the American Museum of Natural History. The conclusion is that ontogeny closely recapitulates phylogeny, that the genesis is gradual or continuous, that the horns arise definitely and determinately. In the bovine series it seems, in accord with the conclusions of Dürst, that the horn first appears as a circular thickening of the skin, accompanied by accelerated growth of the hair preparatory to the formation of the keratin of the horny substance, at a period considerably prior to any sign of the horn in the bony structure of the frontals. This raises the problem, which will form the subject of a special paper in the *Annals* of the Academy, as to what element first arises in connection with horn evolution, namely: (1) the psychic, or desire to use the horn, (2) the epidermal callous or keratin protection of the bony horn center, or (3) the bony or osseous horn itself. It would appear that the psychic tendency must precede the epidermal and that the latter precedes the osseous, but this disputed point requires further investigation.

Skull Measurements in Man and the Hoofed Mammals: HENRY FAIRFIELD OSBORN.

Comparative anatomists and zoologists have been slow to introduce into mammalogy systems of measurement by indices and ratios, which have proved of such universal value in anthropology. It is found among the hoofed mammals, from studies undertaken by the author with the cooperation of Dr. W. K. Gregory, that *cephalic indices and limb ratios* between different segments of the skeleton are far more significant than systems of direct measurement. These cephalic indices of the gradual changes of proportion between different regions of the skull have the value of specific characters and sharply distinguish members of different phyla. For example in the cross between the horse (*E. caballus*) and the ass (*E. asinus*), it is found that the cephalic indices are transmitted as pure non-blending characters.

Among the most significant indices are the following: (1) the cephalic, which is obtained by dividing the total or basilar length of the skull by the zygomatic breadth; (2) the cranial, which is obtained by dividing the basilar length by the postorbital length of the skull; (3) the facial, obtained by dividing the basilar length by the preorbital length of the skull, etc. The horses show proopic dolichocephaly, or elongation of the face,

and a static condition of the cranium, while the titanotheres, in contrast, show opisthopic dolichocephaly, or elongation of the cranium, and abbreviation of the face. Like the phyletic differences of proportion between the horse and the ass, these differences are most exactly expressed by the method of indices.

The application of the ratio method to the limbs of the hoofed mammals has again produced most surprising results. It is found that mammals of different phyla adapted either to "weight" or to "speed" converge respectively toward typical "weight" or "speed" ratios, which are obtained by dividing the length of the lower segments, tibia and radius, respectively, by the upper segments, femur and humerus, metacarpus and metatarsus, respectively. These "weight ratios" and "speed ratios" are far more significant as regards function and phyletic change than the actual or direct measurements.

This subject will be fully treated in the author's forthcoming monograph "The Titanotheres," to be published by the United States Geological Survey.

Whaling in the Olden Time: FREDERIC A. LUCAS.

The speaker exhibited lantern slides illustrating some interesting pictures from old works on whaling and showing the methods practised by the early Japanese, European and American whalers.

At the regular monthly meeting of the section, held at the American Museum of Natural History, February 12, 1912, Professor Bashford Dean presiding, the following paper was read:

Some Factors of Geographical Distribution in South America: JOHN D. HASEMAN.

The speaker outlined his itinerary in Central South America, where he had spent the years 1907-1910 collecting fishes, etc., for the Carnegie Museum and studying the geology, physiography and faunal complexes. He criticized the "static method" of studying geographic distribution as leading to no certain results. He outlined his conception of the geology and former topography of South America as bearing upon the problems of distribution and as being distinctly unfavorable to the "Gondwana land" hypothesis. He also analyzed the faunal similarities between South America and Africa and held that they offered no valid evidence for the former existence of a land bridge between those continents. His results are being published in the *Annals* of the Academy.

WILLIAM K. GREGORY,

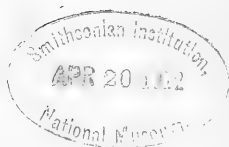
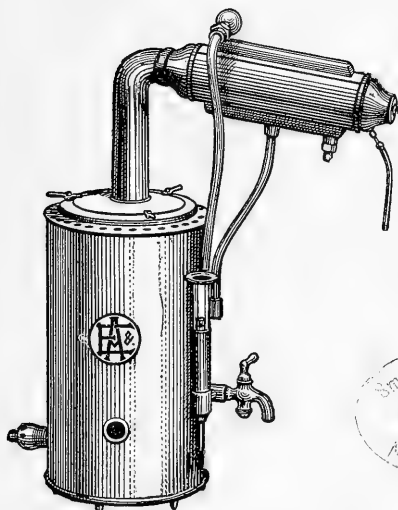
Secretary

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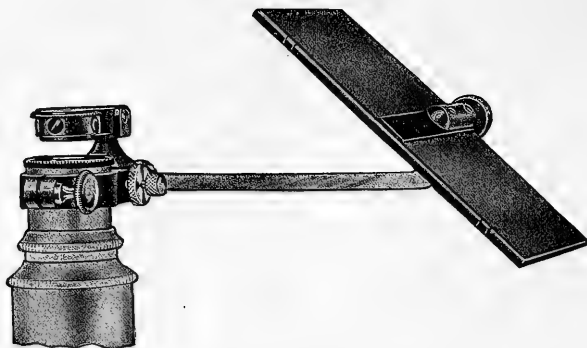
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SCIENCE

FRIDAY, APRIL 19, 1912

THE EFFECT OF RESEARCH IN GENETICS
ON THE ART OF BREEDING¹

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THE knowledge of breeding has advanced so rapidly in recent years that few of us realize the great change that has taken place in our understanding of the fundamental principles, and the effect that this change has had on the methods of practical breeding which we advocate. I had the good fortune to begin my studies and experiments in breeding in 1890, ten years before the rediscovery of Mendel's now famous principles of heredity, or the publication of de Vries's mutation theory. I have thus had the opportunity to follow this change through all its ramifications. From a condition of ignorance and largely of chaos, where all advance was taken as a lucky chance, we have developed to a position where practically each step may be taken intelligently. True, we touch the limits of knowledge on every hand and many of the most fundamental problems still remain unsolved, yet our understanding to-day, which enables us to analyze a plant into its component parts or characters, and then in turn by synthesis to build up a new structure by the combination of different characters into a new race or variety, is to our former understanding as light to darkness. The knowledge of breeding has developed into the science of genetics, and is fast assuming through the orderly presentation and classification of facts, the form of an exact science. Yet with all this advance in our understanding,

¹ Paper No. 27, Department of Plant Breeding, Cornell University, Ithaca, New York. Annual address of retiring chairman of the Plant Section, American Breeders' Association.

the methods of breeding that can be recommended for the use of practical breeders have changed but little in the last twenty years, the greatest change being primarily in the greater surety with which we now make recommendations. It is the speaker's purpose in this address to emphasize certain salient features of the advance that has been achieved, and point out what he conceives to be some of the most important problems awaiting solution.

Twenty years ago our understanding of the principles of breeding was derived largely from Knight's physiological papers and Darwin's "Origin of Species" and "Plants and Animals under Domestication." Verlot's admirable pamphlet "On the Production and Fixation of Varieties of Ornamental Plants" gave a general outline of the best methods then followed, and we derived our knowledge of the use of hybrids largely from Focke's excellent text, "Die Pflanzenmischlinge," published in 1880, and the work of the French experimenter Naudin.

At that time breeders clearly understood the fact that hybrids segregated in the second generation and gave new combinations of characters, and the suggestion was even then present in the minds of scientific breeders, that this segregation of characters took place during the reduction division. At that time breeders, just as definitely as now, planned experiments in hybridizing different varieties or species to secure certain recombinations of desired characters in the hybrids. The experiments in citrus hybridization conducted by Mr. W. T. Swingle and the speaker were planned in 1893 entirely on this basis, yet the principle was in no sense of the word original with us, but was at that time well understood by all practical breeders. This understanding, the speaker thinks, was largely derived from the investigations of

Naudin, though various investigators contributed to it.

With a full understanding of the knowledge and practises of the breeders of two decades ago, it must be admitted that the conception of unit characters and Mendelian segregation was necessary to clarify this knowledge and bring out the latent possibilities of the material presented by nature for the use of the breeder, and it is doubtful whether we even yet adequately comprehend the almost infinite possibilities open to us.

To understand breeding to-day we must clearly understand the conception of unit characters. We no longer conceive the species, race or variety, as a fixed ensemble of characters. Following De Vries, we now commonly conceive the species or variety to be made up of a certain number of unit characters, that are in large measure associated together by the accident of evolution or breeding and which are separable entities in inheritance. We may liken these unit characters to bricks used in the construction of a building, each separate and yet dependent on the others for the maintenance of the structure; as each unit character is dependent on the other unit characters for the maintenance of the plant body. We may think of these unit characters as organic elements similar to chemical elements, that by their recombination through hybridization, form new compounds—new plants—of distinctly different appearance, but which in turn do not affect the unit characters, which may again be separated and led to form other compounds, again resulting in distinct organisms. Related species may possess many distinct unit characters, but ordinarily would be expected to possess many similar unit characters. Cultivated races or varieties ordinarily would differ only in a few unit characters, and difference in a

single unit character would be sufficient to give a distinct and recognizable race or variety. Indeed, the difference between two varieties of a single unit character might mean that one variety would be exceedingly valuable and the other practically worthless. De Vries asserts that unit characters are discontinuous in inheritance and do not exhibit transitional forms. A plant can not be hairy and at the same time smooth, or a fruit yellow and at the same time red. While there is yet much difference of opinion on these questions the preponderance of evidence certainly favors the unit character conception.

If, then, we recognize that species are made up of unit characters and that different species differ in the possession of different unit characters, the great problem in the evolution of species becomes the question of how the new unit character is acquired. Have all unit characters existed from the beginning, or are new unit characters being continuously acquired? A few years ago we supposed that new characters, if acquired in any form, must be seized upon, as it were, by natural selection and preserved, or otherwise that they would be swamped by intercrossing and lost. We now know from Mendelian analysis that a unit character may be apparently lost in crossing, owing to the prevailing presence of its dominant allelomorph, but that in reality it is not lost or apparently changed and will reappear again when it happens that two gametes both bearing the character meet in fecundation. It may remain hidden for many years, but as we are now inclined to view the matter, the character or the determiner of the character would not be permanently lost to the species unless all individuals possessing it were killed before they produced seed. This unit character idea would lead us to the conception of the species as made up of all the unit char-

acters that it has acquired by any means in its development and which still exist. The acquirement of any new unit character would add one more character to the species and double the number of possible varieties or races of the species.

In evolutionary studies we have long recognized that variation was the foundation of evolution and that no evolution was possible without variation, but we have assigned to selection an all-important part as guiding and even stimulating the variation in a certain direction. Darwin and particularly some of his more radical followers have assigned to selection a creative force, in that it has been assumed that when nature by a slight variation gave the hint of a possible change in a certain direction, natural or artificial selection, by choosing this variant and selecting from among its progeny the most markedly similar variants, could force the advance of the variation in the direction indicated. Since Darwin's time this cumulative action of selection has been emphasized so forcibly that we had come to recognize selection as an active force in creation rather than simply as a selective agency. To be the vital principle of evolution, as we now understand the species as made up of heritable unit characters, the selectionist must show that a new character can be created by selection, otherwise selection becomes a secondary principle.

When viewed from the standpoint of the production of a new and definitely heritable unit which mendelizes, the task of selection becomes more doubtful. Darwin's idea, that changes in species required many years and probably many centuries for accomplishment, took the subject largely out of the field of experimentation and in a measure developed a speculative science. One of the greatest contributions to science made by De Vries was to estab-

lish the study of evolution on an experimental basis. With the demonstration that evolution could be studied experimentally, the question of the effectiveness of selection was taken up, and we are now doubtless on the road to a solution of the problem. It is only possible for us here to call attention to a few of the researches in this direction.

The classical researches of De Vries, now familiar to us all, challenged the correctness of the selection theory and sought to show that species originated by sudden jumps or mutations. We may admit that De Vries proved that species or new characters were formed suddenly as mutations, but this would not prove that they might not also be formed or actually induced to mutate by a continuous process of selection. Indeed, in his experiments on the production of a double-flowered variety of *Chrysanthemum segetum* ("Mutationstheorie," Vol. I, p. 523), a few generations of selection led to markedly increasing the number of ray-florets before the ligulate corollas appeared among the disk-florets, the change which he interpreted as the mutation that gave him the double variety.

Johannsen has contributed much to our knowledge of selection and has given us a more exact method of experimentation by his conception of pure lines, biotypes, genotypes and phenotypes. His experiments in the selection of pure lines of beans in an attempt to produce large and small seeded types, have led him to conclude that selection within a pure line is ineffective in producing changes. He did, however, secure new types from pure lines through mutations.

Tower's experiments with the potato beetle in attempting to create by selection, large and small races, albinic and melanistic races, and races with changed color-pattern, although conducted carefully for from ten to twelve generations, failed to

give any evidence of producing permanently changed types. While strains of plus and minus variates gave populations with a range of variation apparently markedly restricted to their respective sides of the normal variation range, still these selected strains did not greatly exceed the normal range of variation in either direction, and when the selection was discontinued, in two or three generations, again produced populations exhibiting the normal range of variation. Clearly no new unit characters had been added by the selection. Tower, however, found that by subjecting the beetles, during the process of the formation of gametes, to certain abnormal conditions, he was likely to obtain mutations in the progeny that would immediately form the beginnings of new races.

Jennings in a series of selection experiments conducted with paramecium, which were continued for over twenty generations, obtained no evidence of a permanent modification of the type.

Pearl has conducted an extended experiment in the selection of chickens in the attempt to produce a breed of high egg-laying capacity. His results have led him to the conclusion that selection alone has no effect in producing a permanent improvement or a change of type.

Up to the present time these are the principal contributions to the subject, that discredit the effectiveness of selection as an active agency.

On the opposite side of the controversy we have the very careful and extensive researches of Castle and MacCurdy in the selection of Irish rats to increase the black-colored dorsal band on the one hand and to decrease or obliterate it on the other. Castle appears to have obtained very positive results favoring the gradual cumulative action of the selection, as he succeeded in markedly increasing the amount of black

in one strain until the rats were almost wholly black, and in the other strain almost wholly obliterating the black. The speaker is not informed whether the inheritance in hybridization of these apparently new characters has been tested. If a new character has been added it should maintain itself and segregate after hybridization.

The experiments conducted by Dr. Smith and others at the Illinois Experiment Station on selecting high and low strains of corn with reference to oil and protein content, have resulted in markedly distinct strains possessing these qualities, which are inherited apparently as long as the selection is continued. It seems certain that the oil and protein content has been increased considerably beyond the maximum which existed in the original race. The writer is informed by Dr. Smith that experiments have been made in cultivating these varieties without selection and that the new characters have been maintained for several years without marked regression. We must apparently conclude then that new heritable characters have been acquired in the course of the selection, but it will probably be difficult to determine whether the advance is to be considered as a cumulative effect of the selection of fluctuations or the gradual purification by the selection, of mutants which occurred during the selection or possibly even before the first selections were made. The purification of a type even when the character concerned is easily observable is known to require a number of years unless both parents are carefully followed. Whether these qualities will segregate as unit characters after hybridization has not been determined so far as the writer is informed.

Very many cases of increases obtained in quantitative characters could be cited, but the majority of the experiments were un-

dertaken primarily to obtain practical results, and whether such apparently new characters would stand the test of unit characters is doubtful.

The improvement of the sugar beet by selection forms a typical and instructive case of this kind. The careful selection of the sugar beet was started over sixty years ago by Louis Vilmorin, at which time a range of variation in sugar content of from 5 per cent. to 21 per cent. was known to exist. Since that time the industry has grown extensively until hundreds of thousands of beets are examined annually and the richest in sugar content selected for seed production. The process of selecting the beets richest in sugar content for mothers has now been continued for sixty years and is practised extensively every year, and yet there is no evidence that the maximum sugar content has been increased, and it is certain that the character of richness in sugar content has not been rendered permanently heritable, as sugar beet growers well know that their success depends upon the continuance of the selection. Here it is certain that no distinct unit character has been added by the continuous selection.

The strongest evidence as to the method of origin of new characters is derived naturally from our knowledge of known cases of the origin of such typical new characters. When we view the evidence critically, I think it must be admitted that in practically all, if not all, of the cases of new characters appearing, they have come into existence suddenly. The cut-leaved *Celedonium*, the cupid sweet pea, *Bursa heegeri*, the Otter sheep, the muley cow, are illustrations familiar to all and doubtless each of us could add several such illustrations from our own knowledge. Such new characters appearing suddenly are heritable and maintain themselves as unit

characters in hybridization. We can not but admit that the evidence of these known cases counts against the origin of characters by gradual cumulative selection.

In summarizing this part of our discussion, we can only state that at present it appears that far the greatest weight of evidence is opposed to the origin of a new unit character through the cumulative action of selection.

Are we, then, to conclude that the practice of breeders in continually selecting from the best for propagation is useless, and must we advise practical breeders to discontinue their selection? How can we do this in the light of the success of the sugar beet breeders? Have not Sea Island cotton growers increased and maintained the length and fineness of their staple by continuous selection? Have not corn growers maintained high productiveness of different strains by selection? Are not the Jersey and the Holstein maintained at a high degree of efficiency by selection? Has not the speed of our trotting and pacing horses been increased and maintained at a high rate by the most careful selection? To one familiar with the history of agriculture and breeding these questions arise fast and are likely to be insistent. There can be no doubt that the practical breeders have made advances by selecting from the best individuals. No genetist or scientific breeder will deny this. It is simply the question of the interpretation of how the results were obtained that is in doubt and whether these results can be considered as permanent, new unit characters. Before we can thoroughly understand this subject it is probable that each individual case will require to be carefully analyzed; to determine the nature of the advance made and the interpretation of the process or processes concerned. At present we can only

partially understand the phenomena presented.

It appears to me that we are dealing in breeding with two markedly distinct types of selection, based on different principles and arriving at different results, both right in principle and productive of equally valuable practical results, but of very different value, when considered from a strictly evolutionary standpoint.

It would seem that such cases of improvement as are illustrated by the sugar beet indicate that the continuous selection, generation after generation, of maximum fluctuations shown by a character, will result in maintaining a strain at nearly the maximum of efficiency; and that within a pure race the progeny of a maximum variate which would probably be classed as a fluctuation, does not regress entirely to the mean of the race in the first generation succeeding the selection, but that we only have a certain percentage of regression similar to the regression determined by Galton. It would further seem to be indicated by the evidence now available that in some cases we may even expect the continuously selected strain to exceed the ordinary maximum of the unselected population. In the Illinois corn experiments the maximum oil and protein content seems clearly to have exceeded the ordinary maximum, and is certainly maintained at a very high degree with a new mode and range of variation. If a new mutant of high protein content has been secured in the course of the experiments with a change of type it is probable that this high protein content will behave as a unit character in inheritance. Upon the other hand, if the results are interpreted as simply the maintenance by isolation of a strain produced by selecting fluctuations, there would probably be a rapid return to

the normal range of variation of this character if the selection was discontinued.

De Vries has pointed out that natural selection can produce races and maintain them, but its power to develop races beyond the natural range of variability remains to be demonstrated.

With reference to his experiments with the potato beetle Tower states:

It is demonstrated that among the fluctuating variations there are individuals which are able to transmit their particular variation and give rise by selection to a race, while the majority are not able to hand on their particular conditions to their progeny. Races developed by selection from such variations have not been carried beyond the normal limit of variability of the species.

These races or selected strains maintain themselves as long as the selection is continued, and when the selection is discontinued rapidly regress to the mean of the species.

The above examples from the sugar beet, corn and potato beetle will illustrate the type of improvement usually secured by practical breeders. By their selection they maintain a strain of high efficiency without having in general exceeded the limits of variation of the species or race and without having produced new unit characters which would be maintained without selection and segregate as pure units following hybridization.

Our different breeds of dairy animals are maintained in a state of high productivity by continuous selection. Cows are followed carefully with reference to their milk-producing capacity and their ability to transmit this quality to their offspring. The ability of bulls to beget high milk-producing daughters is taken as a test of their value. There can be no doubt, the speaker believes, that this selection within the breed maintains the breed in a state of high efficiency and is absolutely necessary

to the success of dairying. Strictly speaking, in the course of this selection, however, no new type has been produced. It is well recognized that the continuous selection is necessary to the maintenance of high milk-producing capacity, and if the selection were discontinued the average milk production of any dairy herd would rapidly decline until it reached the normal mean for the breed concerned. The same can not be said, however, of the breed or race characters, that is, those characters which distinguish the breeds or races from other breeds. Selection is not necessary to maintain the general characters of the Holstein breed for, as long as it is not crossed with other breeds, it will in general maintain its characters so far as color, conformation, and dairy type are concerned. The same may be said of any of our breeds of cattle and horses. The high efficiency of our race horses is maintained by the most careful selection and yet probably in most cases no distinctly new character is added, which would maintain itself as a unit character in inheritance.

It is true that we are dealing here with complex phenomena and limited exact experimentation, and a distinct mutant in the direction of high efficiency might occur at any time and be chosen for breeding which would maintain itself without continuous selection.

It is interesting at this point to recall one of the most common differences between plant and animal breeding which is seldom clearly recognized by practical breeders. Plant breeders most commonly strive to produce new races or breeds with distinctive characters which will reproduce their desirable qualities without continuous selection; while animal breeders almost wholly limit their attention to selection within the breeds already established, to maintain them in the highest state of effi-

ciency possible. The failure to understand this difference in purpose has frequently led to confusion in our discussions.

It is beyond the scope of this paper to discuss the kinds of variation used in these different types of selection, even if we possessed the requisite knowledge, which is doubtful. The speaker may be pardoned, however, for digressing far enough to state that it is his conviction that there is no very hard and fast line between that variation which is in considerable degree inherited, such as is found frequently in high milk-producing cows in selection within the breed, and the mutation which gives absolute inheritance and establishes a permanent new mode. The great difficulty in determining whether there is any true cumulative action of selection which will extend a character beyond the limits of the race or species is met in determining what are and what are not mutations. My experience has led me to conclude that the continuous selection of maximum fluctuations in a certain direction may in some cases lead to the gradual strengthening of the character until finally it may become, more or less suddenly, fully heritable and it would then be recognized as a mutation.

In many cases we find exceedingly small differences maintaining themselves generation after generation under different environments when the lines of descent are kept pure. A marked illustration of this is afforded by Mr. Evans's studies on pure lines of *Stellaria* reported at this meeting. The segregation of such characters in hybridization would be exceedingly difficult to recognize if it did occur. Again the occurrence of such small mutants, if we may so designate them, within a breed under selection, if not recognized and isolated, would be crossed with fluctuations and cause variations which would be recog-

nized as regressions in the highly selected strain.

I think it will have become clear from the above discussion that in the present state of our knowledge of selection we can only advocate that practical breeders continue their selections as in the past. This is particularly true in the cases where it is the idea to maintain the race or breed at its highest efficiency. In the case of plant breeders working to produce new races, the mutation theory introduces a new element and leads the breeder to search for a mutant possessing desirable characters which he can isolate and which he may expect will reproduce its characters as soon as he has purified the type from mixtures derived through hybridization with other types. He will select the type to purify it rather than to augment its good qualities.

Returning again to the question of new characters, we may profitably question more definitely where such new characters come from, if they are not produced by selection. Clearly, no problem is of more importance to the breeder than to be able to definitely produce or cause such new characters to appear. If the breeder must await the pleasure of nature to secure the changes he desires, the waiting may be long and tedious. If he must watch thousands of plants of a certain race or species every year in order to find the apparently accidental variation or mutation in the direction of the improvement he has in mind which may rarely or never be found, the process will be so hazardous that we should have to await the accidental discovery of any new characters. Indeed, up to the present time we have had practically no other recourse than to await the accidental discovery of such new characters. We, however, have had many theorists and investigators who believed that changed environment would stimulate the production

of variations in the direction of better fitting the organism to its environment. Lamarck and his followers have strongly maintained this hypothesis and many scientists even to-day believe in the effectiveness of environment in developing adaptive changes. Breeders have carried this principle so far as frequently to advocate the growing of plants in the environment most likely to produce the change desired, as, for instance, cultivating tall plants like twining beans in the north or at high altitudes if it is desired to produce a dwarf type or, *vice versa*, breeding the plants in the south and at a low altitude if a giant or tall type is desired. Weismann and his school of followers have apparently exploded this idea by demonstrating that characters acquired as a result of changed environment are merely physiological changes and are not inherited. The question, however, is by no means settled and we must await further evidence.

Knight believed that increased food supply caused an increase in the range of variation and that it was important for breeders to manure their plants heavily. De Vries, on the contrary, would have us believe that such variations are fluctuations and non-heritable. The studies of Weisse, Reinhold, MacLeod, Tammes and Love have given us many instances where the range of variation is increased as a result of food supply and other instances where the variation is apparently greater on poor or sterile soil.

It would seem that any treatment that would increase the range of variation, in plants that are grown for breeding purposes would be valuable, but it still remains to be definitely proved whether such increases in the range of variation are in any marked degree heritable and whether valuable maximum variates can be more frequently produced in this way than would

be found in similar groups of plants under ordinary treatment.

It is only very recently that the idea has developed that we can go farther than possibly change the environment. With the publication of MacDougal's researches in 1906 describing mutations that were apparently caused by injecting the capsules of plants with certain solutions, such as zinc sulphate, magnesium chloride and the like, a possible new method of forcing variations was introduced. MacDougal apparently obtained marked variations as a result of his treatment, which were inherited in succeeding generations.

Tower, by subjecting potato beetles during the formation of the germ cells to extremely hot and dry or hot and humid conditions with changes of atmospheric pressure, was able to cause the development of marked changes or mutations which were found to transmit their characters true through several generations and which segregated as unit characters following hybridization. He concludes from his experiments "that heritable variations are produced as the direct response to external stimuli."

Gager has produced similar changes in plants by subjecting the developing ovaries of plants to the action of radium rays and a number of similar studies by Hertwig and others indicate that radium emanations have a very active effect on both plants and animals.

While the evidence favoring the value of such external stimuli as the above in producing new heritable characters is apparently definite and positive, the extent to which the method can be used in practical breeding has not been determined, and indeed we must await further evidence before we can finally accept the evidence, or the interpretation of the evidence, presented in these very valuable and suggest-

ive researches. Dr. Humbert carried out experiments in the speaker's laboratory in which the capsules of a pure line of a wild plant *Silene noctiflora* were injected with the solutions used by Dr. MacDougal, and although the number of plants handled (about 15,000) was apparently as great or greater than was used in MacDougal's experiments, no mutations were found in the treated plants which were not also found in the untreated or check plants.

Some observations and experiments are recorded in literature which indicate that mutilations or severe injury may induce the development of mutations. Most noteworthy among such observations are those of Blaringham, who by mutilating corn plants in various ways, such as splitting or twisting the stalks, apparently produced variations which bred true without regression and which he described as mutations. My own observations on the great frequency of striking bud variations on recovering trunks of old citrus trees in Florida, following the severe freeze of 1894-5, also furnished evidence in support of this theory.

In general, it is assumed that in hybridization we are dealing merely with characters already present and that new characters which appear are due to the different reactions caused by new associations of unit characters in their mutual effect on one another. It is, however, possible that new unit characters may result from the commingling of the different hereditary units which are to be considered as mutations rather than new combinations. As is well known, Weismann long ago advanced the hypothesis that valuable variations in evolution were due to the commingling of protoplasts from different parents having different hereditary tendencies, a process which he called "amphimixis." He did not have in view, however, the formation

of new unit characters as distinct from new combinations.

The most marked case known to the speaker, of the appearance of a new character which was apparently caused by the stimulation of hybridization, is the development of a marked spur or horn on the lip of a hybrid *Calceolaria*. This occurred among a series of hybrids between a herbaceous and a shrubby species made by Professor Atkinson and Mr. Shore, of the botanical department at Cornell University. One or two tapering horns about an inch in length and from 2 to 4 millimeters in diameter at the base, spring from the upper surface of the large corolla lip and grow erect to its surface. No such character, so far as can be learned, is known in the *Calceolarias* and it would seem to have been caused by the hybridization. It can not, apparently, be considered as a combination of any of the known characters of the species concerned.

Such apparently new characters appear rather commonly among large batches of hybrids, and while there is little evidence available on the subject, I am inclined to believe it will be found that hybridization may stimulate the production of new unit characters, which mendelize with the parental types.

While the evidence at our command regarding the artificial production of mutations is not yet sufficiently exact and trustworthy to enable us to draw definite conclusions and formulate recommendations for practical breeders, it may be stated that this is apparently one of the most profitable lines of experimentation for the immediate future.

Thus far I have only incidentally discussed hybridization and the advance of our knowledge in this direction. The scope of this address will not allow of an adequate treatment of this subject and it ap-

peared wiser to discuss more in detail the problems of selection and variation. I can not, however, close this address without referring to this very important field of genetics.

No discovery in the field of breeding has had more effect or is more far reaching in its importance than the discovery of what have now come to be known as Mendel's principles of heredity. While, as stated in the beginning of this address, breeders had long before the rediscovery of Mendel's papers come to understand that there was a segregation of characters in the F_2 generation and that it was possible to recombine in certain hybrids the desired characters from different parents, there was no definite understanding of the underlying principles, and no conception of the almost infinite possibilities of improvement which the field of hybridization opened to us.

The law of dominance, while not universal, has explained many cases of prepotency in one generation and failure of certain individuals to transmit the character in the next generation. It has explained many cases of latency of characters and may account for all such cases.

The law of segregation has shown us that the splitting of characters follows a definite method and that we can in general estimate the frequency of occurrence of a certain desired combination, if we know the characters concerned to be simple unit characters.

The study of hybrids has been resolved into a study of unit characters and their relation to each other. By hybridizing related types having opposed characters and observing the segregations which occur in the later generations, we analyze the characters of each type and determine when we have a character pair. The researches on this subject by Mendel, Bateson, Davenport, Castle, Punnett, Shull, Hurst, Cor-

rens, Tschermak, East and dozens of other now well-known investigations, have developed a science of heredity of which we had no conception a few years ago.

We can now study the characters presented by the different varieties of a plant or of different species, which can be crossed with it and definitely plan the combination of characters desired in an ideal type, and can with considerable confidence estimate the number of plants it will be necessary to grow to get this combination. We now know in general how characters behave in segregation and inheritance so that we can go about the fixation of a desired type, when one is secured, in an orderly and intelligent way.

The farther the study of characters is carried the more we are coming to realize that the appearance of apparently new types following hybridization is due to recombinations of different units which in their reactions give apparently new characters. As an illustration, in a study of pepper hybrids which I have carried on during the past four years it has become evident that the form of plant and branching is due to three pairs of characters or allelomorphs; namely, first, erect or horizontal branches; second, large or small branches; and third, many or few branches. In crossing two medium-sized races, one with large, horizontal and few branches, and the other with small, erect and numerous branches, there result many new combinations of characters, among which appear some with small, horizontal and few branches, which gives a dwarf plant, and others will have a combination of large, erect and numerous branches, which gives a giant plant. These dwarfs on the one hand and giants on the other, appear as distinct, new creations, though they are very evidently merely the recombinations of already existing unit characters, and dwarf-

ness and giantness are the results of the reaction of the different units combined.

When we remember the large number of distinct characters which are presented by the very numerous varieties of any of our cultivated plants, we arrive at an understanding of the possibilities of improvement which the field of hybridization affords, yet I doubt if many of us have even then an adequate conception of the possibilities. Possibly I may make this more clear by an illustration from my timothy breeding experiments. While the various characters presented by the different types under observation have not been carefully studied in inheritance, the following characters can be distinguished plainly, and from observations on accidental hybrids are known to segregate. The following is a list of 28 such character pairs which it is believed will prove to be allelomorphs.

TIMOTHY CHARACTER PAIRS

Heads

- Long or short.
- Thick or thin.
- Dense or lax.
- Greenish or purple when young.
- Gray or tawny when ripe.
- Simple or branched.
- Erect or nodding.
- Continuous or interrupted.
- Apex blunt or pointed.
- Base blunt or attenuated.
- Seeds large or small.

Leaves

- Long or short.
- Broad or narrow.
- Erect or reversed.
- Rolled or flat.
- Clustered at base or extending to top of culm.

Culms

- Tall or short.
- Thick or thin.
- Straight or wavy.
- Erect or bent outward.
- Green or purplish.
- Many or few.

Nodes

- Many or few.
- Green or brown.
- Internodes long or short.

Habit Characters

- Lodging or non-lodging.
- Rusty or rust resistant.
- Early or late season.

It is possible that some of these characters may be expressions of the same unit, but in a number of cases they certainly represent several different unit characters. For instance in length of head, height of culm, number of culms, and season of maturing, several different degrees are certainly present which are fully heritable. Doubtless there are many more than 28 pairs of unit characters which could be distinguished by careful study. If we have two pairs of characters, such as tall or short and early or late, we know that 4 homozygous combinations are possible. If three pairs are considered, 8 combinations are possible. Every time we add a different character pair we double the number of different combinations that are possible. Twenty-eight character pairs would thus give us as many possible combinations as 2 raised to the 28th power, or the astonishing number of 268,435,456. It would be possible then to produce this tremendous number of different varieties of timothy if there was any reason to do so, and each variety would be distinguished from any other variety by one distinct character and would reproduce true to seed.

The task of the breeder, then, is to find which among these character combinations gives the superior plant for commercial cultivation. He will soon eliminate certain characters as unimportant and concentrate his attention on those qualities that are essential.

It would be interesting to discuss the factor hypothesis, purity of germ cell, sex-

limited inheritance and other important problems connected with inheritance studies, but I have already too severely tested your endurance.

As breeders and genetists we have every reason to congratulate ourselves on the rapid advance of our science and the growing recognition of the importance of the subject in practical agriculture. Colleges throughout the country are extending their courses of study to include genetics. In almost all of the experiment stations studies on genetics and practical breeding are now given fully as much attention as any other subject. With all of this advance, however, only in a few institutions have there been established special professorships or investigatorships in breeding or genetics. If the subject of genetics is to be properly taught or the investigations are to reach the highest standard, it is clear that men should have this as their special and recognized field. The subject should no longer be assigned indiscriminately to the horticulturist, agronomist, animal husbandmen or dairymen. We must establish more professorships of genetics or breeding.

HERBERT J. WEBBER

CORNELL UNIVERSITY

*GENERAL HYGIENE AS A REQUIRED
COLLEGE COURSE¹*

DURING the last two or three decades, scientific method has been increasingly applied to the solution of problems bearing upon the health of the individual and of the community. Out of the region of controversy, in the study of problems of the maintenance and preservation of health, there has thus come to maturity during comparatively recent years a body of organized knowledge, of which the cardinal facts and broader methods may, perhaps,

be grouped together under the title "general hygiene." The more technical and detailed side of the same subject is already taught as a professional course in some of our medical schools as "hygiene" or, with nominally a more specialized bearing, as "public health." On the other hand, a somewhat slight and semi-popular treatment of several hygienic topics is given in certain colleges by the instructors in physical training. Between these two types of instruction, a course in general hygiene, very substantial although non-technical, would strike a happy mean.

Before answering the question whether the teaching of general hygiene, thus defined, to every college undergraduate is necessary, it may first be enquired whether the average student is not already well-informed on this subject. On investigation, it will be found that he may have, in an informal way, attended one or two popular health lectures; that he has a hear-say, gossiping knowledge of the names of the commoner diseases, with a more personal but badly proportioned knowledge of one or two; has never seen a microbe, although he can use the word correctly; trusts implicitly to the initiative of the local civic authorities (who are less well educated than himself) for improvement in his supplies of water, milk and food; and is indebted to his newspaper or magazine for a variety of scraps of knowledge in the domain of preventive medicine, which scraps, if not partially forgotten, are admixed with much that is vague, or controversial or else fallacious. The fact is that his knowledge of general hygiene is altogether accidental and amateurish in character. Now, if the average undergraduate is in a twilight of ignorance in regard to aspects of this subject where knowledge would be vitally important to himself, he is in still greater darkness in

¹ The substance of an address given at Oberlin College, December 1, 1911.

regard to those aspects which are of importance to the community. In this respect, therefore, he is altogether unqualified for good citizenship.

It is true that the larger cities have, in general, progressive health departments. The chief difficulty which these departments have to contend with in their efforts at reform is the ignorance of the public. Their battle is the old battle against ignorance. If only the people had a clear knowledge of the facts, they would themselves clamor for the very reforms that the health departments can not yet introduce simply because public opinion is not yet sufficiently educated. In the smaller cities and towns, many municipal conditions are excellent because their utility is obvious and because, being of a purely economic character, they are understood by business men. This is not at all the case with the hygiene of such towns, for the good reason that people and civic authorities alike do not, for want of the appropriate education, realize what conditions are desirable for the public health. Milk inspection and food inspection are not rated at their true value for want of the necessary mental perspective. The town sells water whose purity is not controlled. Appropriations made for the health department are entirely inadequate and the health officer, therefore, lacks the sinews of war against disease. This state of matters is typical of the smaller cities and towns of this country. The remedy lies in an educated public opinion; and who, in such a community, should be the leaders and educators of public opinion rather than the college graduates?

It is not at all necessary, in the meantime, to make any rigid decision what should constitute the essentials of a course of general hygiene, nor to determine how the emphasis shall be distributed between

personal hygiene and public hygiene. The precise content of the course can be outlined after it is decided that something of the kind must be taught. Now, if there is any reason for teaching civics in college, there is at once a still better reason for teaching public hygiene. Again, if you make "physical culture" a required course and compel each undergraduate to take exercise, are you not in a position to join to this an exhortation that he shall sterilize his toothbrush? It is absurd that any post-Levitician scheme of physical education should rely upon exercise alone for health.

To a people living amid artificial surroundings, the kind of special knowledge that promotes physical efficiency may not be the most important of all knowledge, but it is at least a very necessary kind of knowledge. Upon this matter, Herbert Spencer's judgment is still modern. We are probably tired of the threadbare subject of ventilation, and bored at the mention of the low humidity of steam-heated buildings. But do many of us yet ventilate adequately, or suitably moisten our living air? Do we have in mind the direct relationship between ventilation and bad-air diseases in terms of facts sufficiently definite to spur us to action? Are we positive and militant in our knowledge of the sources of infection and the modes of transmission of communicable diseases; or, when we ought to act, do we remain supine because our knowledge is not a compelling knowledge? Can our typical undergraduate pass a simple examination even on such well-canvassed subjects as diphtheria antitoxin, deep cuts and tetanus, mosquitoes and malaria, pasteurization of milk, sunlight and germs, spitting, dust, flies and the dozen other familiar newspaper topics; or is his knowledge even of these topics too entirely in journalese?

It should be recalled that the war with ignorance is nowadays not only with ignorance of the ways of nature, but also with ignorance of the deceits and methods of wickedness of our fellowmen. As part of their equipment for the battle of life is it, then, anything more than common fairness to give to our college youth at least the bare facts in regard to typical "cough cures" (containing morphine, codeine, heroine, cannabis indica, chloroform, ether), "catarrh powders" (containing cocaine, etc.), asthma, headache, colic, tobacco and drug habit cures (the last themselves containing morphine) and medicated "soft-drinks" (containing caffeine, extract of kola nut, etc.)? "It may be of interest to note that life insurance companies are considering the status of soft-drink habitués as future risks."² When the particular drug alcohol is under discussion, we are reminded of the strongly partisan, unbalanced and therefore unconvincing oratory of a certain type of temperance lecturer. Upon this and several other subjects it were surely wiser to give the undergraduate the benefit of a scientific and dispassionate statement of the facts, removed from all suspicion of the distortions arising from controversy. The facts require no garnishing.

It is a platitude that the fraudulent, worthless or harmful drugs, "remedies" and "treatments" are introduced to and used by a very wide public because of their very wide advertising in the newspapers. There are, indeed, a few newspapers which will not print such advertisements, but these are honorable exceptions to a general rule. The government and medical association laboratories, whose analyses expose the nature of these drugs, do not similarly advertise their exposures in the public

press, nor do they by their own publications reach a wide public. Under these circumstances has not the college, as a public institution, a duty to fulfil in spreading the truth? For all our colleges must be regarded as public institutions—state-aided colleges and universities most obviously of all. Stating the case generally, therefore, can we not fairly say that the colleges, in their relation to the state, are in duty bound, in partial return for public moneys expended upon them, to contribute, by educating their students in hygiene, towards that most important factor of the public welfare, the public health?

Turn now to the question whether instruction in general hygiene as a required course could be sound educationally without the postulation of half a dozen prerequisite courses that could not be made required courses. The *a priori* answer to this question must be left to the experts. In our opinion, however, there are no difficulties here that are insurmountable. It may be recalled, in the first place, that, in some states, the public schools, with their "physiology" teaching, have already begun a type of instruction which it would be perfectly good pedagogy to continue in college. That the school should be more progressive than the college seems, by the way, to be the normal condition of affairs. The general hygiene course need not necessarily be made a freshman course; thus, many students may come to this course with some previous training in contributing sciences. Taking, therefore, what would appear to be the most unfavorable case, that, namely, of the student who has touched no science whatever, let us consider to what pedagogical catastrophe he will be subjected in studying general hygiene. It has been said above that the rapid modern growth of this science is

²Dr. Kebler, chief of the Division of Drugs, Bureau of Chemistry, U. S. Dept. of Agriculture.

attributable, in general terms, to the increasing application of scientific method to health problems. It may now be added that many of the very most striking examples of successful application of scientific method are to be found precisely in this domain. Here, therefore, is to be found one of the richest fields in which to exemplify and illustrate scientific method. To a student entirely innocent of science such a course would, in this way, be of superlative value as an introduction to scientific method, and this apart altogether from any utilitarian value inherent in the facts presented. Laboratory work, although we often make a fetish of it, is by no means a *sine qua non* in the teaching of scientific method; and the teaching of a substantial though non-technical course in hygiene would, from the very variety of the contributing sciences, offer exceptional opportunities for utilizing the whole battery of modern methods of class-room demonstration.

Some one has truly said that, as a nation, we are prodigal of nothing in so great a degree as of our health. It is the chief of the wastes of our national resources, our largest preventable waste. To be effective, a knowledge of preventive medicine must be in the hands of the many, whereas a knowledge of merely remedial medicine may be effective in the hands of the few. To conserve our health resources, therefore, the logical policy is plainly to teach prevention to many and cure to a few. To the medical student, who is a specialist, teach cure; but to the general student teach prevention. If prevention can not be taught more widely still in the community, its teaching in colleges makes it at least possible that, in this matter, the college graduates may become the little leaven that shall leaven the whole lump.

If it be true that the last few decades

have witnessed abnormally swift progress in the science of preventive medicine, and if it also be true that the development of a social conscience has been unusually rapid in recent years, then it may well be the case that the time for requiring the teaching of general hygiene in our colleges is now at hand.

ALAN W. C. MENZIES

THE UNIVERSITY OF CHICAGO

ELIZABETH THOMPSON SCIENCE FUND

THE thirty-seventh meeting of the board of trustees was held on February 9 last at Cambridge, Mass. The records of the last meeting were read and approved. The following officers were elected:

President—Edward C. Pickering.

Treasurer—Charles S. Rackemann.

Secretary—Charles S. Minot.

The secretary reported that a pamphlet, giving the record of the Fund for the twenty-five years of its existence, had been prepared and printed in accordance with the vote of last year. This carries the record of the fund to April, 1911. In compiling the matter for this record valuable assistance had been received from Dr. F. T. Lewis. Copies of the report have been sent to each of the trustees, to all living recipients of previous grants, and to a small number of libraries and institutions. Any one desiring a copy of the report should address the secretary.

The secretary reported that additional publications had been received connected with grants, the record of which had been closed, as follows:

139. Joh. Königsberger.

153. W. Doberck.

159. B. M. Davis.

It was voted to close the record of grants 117, E. Salkowski, and 146, M. Nussbaum. No reports had been received from the holders of grants Nos. 22 and 27, 109, 112, 124 and 147. The trustees much regret that the recipients of these grants have failed to ful-

fill the obligations they have assumed. Reports were received from twenty-seven holders of grants and accepted as reports of progress. It was voted to make the following new grants:

No. 170, \$100 to Professor Arthur L. Foley, Indiana University, Bloomington, Indiana, for photographic researches on the spectra of various gases, the money to be applied to the purchase of quartz tubes. (Application 1,243.)

No. 171, \$250 to Professor Paul Schiefferdecker, Bonn, Germany, for the investigation of the microscopic structure of muscles. (Application 1,252.)

No. 172, \$75 to K. Stolyhwo, rue Kaliksta, Varsovie, Poland, for the archeological exploration of the Cave of Lary, Poland. (Application 1,264.)

No. 173, \$180 to Professor H. Konen, Fürstenbergerstrasse 4, Münster, W., Germany, for the study of the lower end of the spectrum, the money to be used for the purchase of quartz rock salt objectives. (Application 1,245.)

No. 174, \$100 to Dr. Paul D. Lamson, Bahnhofstrasse 20, Würzburg, Germany, for researches on the pharmacotherapy of snake-bites. (Application 1,258.)

No. 175, \$40 to W. Dobereck, Esq., Kowloon, Elgin Road, Sutton, Surrey, England, for observations on comets, the money to be used for the purchase of a comet eyepiece. (For application, see Grants made, Report 383.)

No. 176, \$250 to Professor Th. Boveri, Zoologisches Institut, Würzburg, Germany, for experiments on the rôle of the separate elements of cells in heredity. (Application 1,249.)

CHARLES S. MINOT,
Secretary

HARVARD MEDICAL SCHOOL,
BOSTON

JOHN BERNHARDT SMITH

THE many personal friends of Doctor John Bernhardt Smith, state entomologist of New Jersey, had known for many months that he was in a most serious condition of health, but were none the less shocked and grieved to learn of his death on March 12 last.

Few men have contributed more to the advancement of the study of entomology in the United States, through both the systematic

and economic sides, than has the late New Jersey entomologist. He was born in New York City on November 21, 1858, and was educated in the schools of New York City and Brooklyn. He was admitted to the bar in 1880 and practised law in Brooklyn between 1880 and 1884. As a young man, he was greatly interested in the study of insects and joined the Brooklyn Entomological Society, devoting himself at first to the study of Coleoptera and afterwards turning his attention to Lepidoptera. He became the editor of the *Bulletin* of the Brooklyn Entomological Society which afterwards developed into the journal known as *Entomologica Americana*, the most prominent periodical of its kind in those days for the publication of short papers and notes.

Up to 1884, Doctor Smith was known only as a systematic entomologist, but in that year he was brought by the late C. V. Riley to Washington and became field agent of the Bureau of Entomology, U. S. Department of Agriculture, and spent two years in investigating insects affecting the hop and the cranberry. In 1886, he was transferred to the U. S. National Museum, where he remained as assistant curator of insects until 1890.

During this period, he was active in his systematic work publishing a number of excellent papers, and became prominent in the scientific life of Washington, joining the Cosmos Club and being made secretary of the Biological Society of Washington.

With the founding of the state agricultural stations under the Hatch Act, he was appointed entomologist of the State Agricultural Experiment Station of New Jersey and there really began his important economic work, which lasted until his fatal illness came. All the difficulties of insect emergency which the agricultural and horticultural interests of New Jersey had to face during that period were met by Doctor Smith with a rare comprehension and an equally rare ability to handle them. He was foremost in the work against the San Jose scale in the early days and took an equal rank in the warfare against all the other threatening foes to agriculture and, in the last few years, conducted an admirably

planned and successful crusade against the traditional insect of New Jersey, the mosquito. His mosquito work was based upon original observations which introduced revolutionary ideas into culicidology and his work on the salt marsh mosquitoes which fly inland from their breeding-places for many miles came as a startling revelation to the "old fogey" students of mosquitoes, of whom the writer of this notice was one. Further than that, Doctor Smith so impressed his views upon the legislature and the governor of his state that his mosquito work was supported by large appropriations.

Through all this period of economic work, Smith was constantly working upon other aspects of entomology. Every few months would appear a systematic paper upon that difficult and complex group, the family *Nocuidæ*, and in the course of his New Jersey career he published two enormous catalogues of the insects of New Jersey.

He was also the author of two admirable books, "Economic Entomology for the Farmer and Fruit Grower," Lippincott, 1896, and "Our Insect Friends and Foes," Lippincott, 1909. In addition to the position of entomologist of the New Jersey State Agricultural Experiment Station, he was professor of entomology in Rutgers College and state entomologist of New Jersey. He was president of the Association of Economic Entomologists in 1896 and president of the Entomological Society of America in 1910. In 1891 he was given the honorary degree of Sc.D. by Rutgers College.

While not a pioneer in entomology in the United States, Smith was a leader in the second generation of men who have helped to make American economic entomology assume the first rank in the world. L. O. HOWARD

SCIENTIFIC NOTES AND NEWS

PROFESSOR ABBOTT LAWRENCE ROTCH has bequeathed to Harvard University the Blue Hill Meteorological Observatory, which he established in 1885 and had directed up to the time of his death. He has further provided an endowment fund of \$50,000.

THE will of Lord Lister disposes of property valued at £66,166. In addition to a number of family bequests he left £10,000 each to the Royal Society, King Edward's Hospital Fund, King's College Hospital and the North London and University College Hospital. He stated that he did not wish that his name should be "in any way associated with these sums in the future." He also left £20,000 to the Lister Institute of Preventive Medicine, and requested his nephews, Mr. Rickman John Godlee and Mr. Arthur Hugh Lister, to arrange his scientific manuscripts and sketches, destroying or disposing of such as were of no permanent scientific interest. He left his manuscripts and sketches when so arranged to the Royal College of Surgeons, England. In the bequest of his Orders and medals to the Edinburgh University, Lord Lister stated: "I expressly declare that it is my intention that the university authorities for the time being shall be perfectly at liberty to dispose of all or any part of the gift—for example, by having the medals melted down or the diplomas or other writings destroyed—at any time and in any manner that may seem to them desirable."

DR. IRA REMSEN has tendered his resignation as president of the Johns Hopkins University. He will remain professor of chemistry, which he has been since the opening of the university in 1876. Dr. Remsen's letter of resignation in part reads as follows: "For some time past it has seemed best to me that I should retire from the presidency of the university, but those whom I have consulted have urged me to postpone action until certain important things have been accomplished. This has now been done and I accordingly tender my resignation to take effect at the end of the present academic year. I have held the position for eleven years. This covers a fairly well-defined period in the history of the university, a period of steady growth and especially of preparation for a new era, which while maintaining and strengthening the old ideals and high standards of the university, will lead to larger and in some directions new

fields of activity and usefulness, if properly administered. We are face to face with new problems which will require wise consideration for many years to come. It is not to be expected that I shall be able to guide the policies which are to be inaugurated for a sufficient length of time to insure their ultimate success. I, therefore, feel that they should be intrusted to one having a reasonable expectation of long term of service.

THE Elisha Kent Kane Medal of the Geographical Society of Philadelphia has been awarded this year to Professor Wm. Morris Davis, of Harvard University.

THE Longstaff Medal of the Chemical Society, London, has been presented to Dr. H. Brereton Baker, F.R.S.

THE Turin Academy of Sciences has awarded the Vallauri prize of £800 for contributions to the progress of physics in the period of 1907-1910 to Professor A. Righi and Professor J. Perrin.

THE Royal Geographical Society has made its awards as follows: The Victoria medal to Sir George Darwin, of Cambridge University; the founders medal to Mr. Charles Montague Doughty, known for his explorations of Arabia; the patrons medal to Mr. W. Caruthers, who has conducted expeditions in Turkestan and Arabia; the Murchison bequest to Captain W. C. Macfie, R.E., for his topographical survey of Uganda; the Gill memorial to Captain F. M. Bailey, who has made explorations in China and Thibet. The Cuthbert Peek fund to Mr. Cecil Clementi, who has traveled extensively in central Asia; the Black bequest to Mr. L. A. Wallace, who has made surveys in Rhodesia.

PROFESSOR E. METCHNIKOFF, assistant director of the Pasteur Institute at Paris, has been elected foreign associate of the French Academy of Sciences, in succession to Sir Joseph Hooker.

SIR DAVID GILL, K.C.B., F.R.S., has succeeded Lord Cromer as president of the Research Defence Society; Lord Cromer, Mr. Balfour, Sir Edward Elgar, O.M., Mr. Rud-

yard Kipling and Lord Rayleigh, O.M., have consented to be vice-presidents of the society.

MR. C. E. ADAMS has been appointed government astronomer for the dominion of New Zealand.

MR. HARLAN I. SMITH has been elected honorary curator of archeology in the American Museum of Natural History.

PROFESSOR J. C. ARTHUR and Dr. Frank D. Kern, of Purdue University, are spending a few days with Professor F. E. Lloyd, at the Alabama Polytechnic Institute, making it the center of field operations in the study of the *Uredineae*, with the especial purpose of identifying the at present unknown alternate hosts of certain species.

DR. W. H. WELCH, of the Johns Hopkins University, delivered the convocation address before the students of the University of Wisconsin on April 12.

At a meeting of the Southern California Academy of Science on April 6, Dr. David Starr Jordan, president of Stanford University, gave an address on "Eugenics."

THE Norman W. Harris lectures of Northwestern University will be given by Dr. Milton J. Rosenau, professor of preventive medicine and hygiene in Harvard University. The lectures will be delivered from April 15 to 20, the general subject being "Milk and its Relation to Public Health." The successive lectures deal with "Dirty Milk," "Diseases Spread by Milk," "Clean Milk," "Pasteurization" and "From Cow to Consumer."

MRS. CHRISTINE LADD FRANKLIN has given three university lectures on color vision before the department of psychology of Columbia University, as follows:

March 25—"The Theory of Color Theories—The Color Triangle and the Color Square—The Facts inconsistent with the Hering Theory."

March 27—"The Young-Helmholtz Theory in its Latest Form—its Indispensableness and its Inadequacy."

March 29—"The Recent Views on Color—Bruner, Pauli, Bernstein, Schenck—The Development Theory of Color."

DR. D. T. MACDOUGAL gave a lecture on the "Physical and Biological Aspects of American Deserts" to the members of the Colonial Institute, Geographical Society and Natural Science Society of Hamburg on March 23.

DR. R. M. PEARCE, professor of research medicine at the University of Pennsylvania, will deliver at the Syracuse Medical School the annual Alpha Omega Alpha address of the Gamma of New York Chapter. The title of the address is "Medical Education." Dr. Pearce will be the guest of honor of members of the fraternity at their annual dinner at the Onondaga.

DR. W. A. EVANS, sanitary expert of the Chicago *Tribune*, has given three lectures at the University of Illinois on health topics. Dr. Evans aided in the establishment several months ago of the Champaign County Anti-tuberculosis Health League which is now making a sanitary survey of the county and has an employed inspector, Dr. Carrie Noble White.

PROFESSOR IRVING FISHER, of Yale University, lectured before the undergraduates at Oberlin College on April 4 on "Some Aspects of the Modern Public Health Movement." Dr. Fisher explained the significance of the International Health Exposition at Dresden, and devoted a large part of his address to emphasizing the value of eugenics. He called particular attention to the scientific methods employed in Germany and in Sweden to guard against the spread of tuberculosis and typhoid fever, and gave a brief analysis of the statistical treatment of the health problem in the United States, urging the great need for more thorough registration of births, deaths and the general care of vital statistics by scientific methods.

THE Academy of Natural Sciences of Philadelphia, at its meeting of April 2, adopted the following minute:

The Academy of Natural Sciences of Philadelphia has heard with deep regret of the death of Professor Thomas Harrison Montgomery, Jr., on March 19, 1912. Professor Montgomery was a grandson of Samuel George Morton, president of this academy from 1849 to 1851, widely known for

his collection and study of human craniology. To that ancestor we may trace Montgomery's taste for natural history which led him to study zoology in the University of Berlin (where he received the Ph.D. in 1894) and to fill positions of instruction and research in the Wagner Institute, the Wistar Institute, the Woods Hole Marine Biological Laboratory and the Universities of Texas and of Pennsylvania. He was elected a member of the academy February 23, 1897. He served on the Committee on Instruction and Lectures in 1903 and on the Committee on Accounts from 1909. He was the first to respond to the invitation to contribute to the Centenary Memorial Volume and his memoir on Human Spermatogenesis was the last paper which he completed, although he did not live to read it at the anniversary meeting. Barely more than thirty-nine years of age when he died, he would have been justified in a feeling of pride in what he had accomplished. He had made fruitful suggestions on the mechanism of inheritance, based on his studies of minute details of the structure of the germ cells; he had investigated the anatomy of the unsegmented worms, rotifers and spiders; he had made known many interesting habits of spiders and of birds; his breadth of outlook and of zoological knowledge was displayed in his book on the "Analysis of Racial Descent in Animals." From all that he had done we rightly expected much to come from his further researches and our sorrow at his departure is made keener by his fullness of promise.

MR. GUSTAV POLLAK is preparing a biography of Michael Heilprin and his sons, and will be glad to receive letters by the late Professor Angelo Heilprin. They may be sent to 21 West Eighty-fifth Street, New York.

DR. PERRY L. HOBBS, professor of chemistry at Western Reserve University, died on April 6, aged fifty-one years.

THE death is announced of Dr. P. N. Lebedew, professor of physics at Moscow, known for his work on the pressure of light.

THE eighteenth meeting of the Association of Teachers of Mathematics in the Middle States and Maryland, was held at Syracuse University on April 6, under the presidency of Professor I. J. Schwatt, of the University of Pennsylvania.

THE eleventh annual meeting of the North Carolina Academy of Science will be held at

the University of North Carolina, Chapel Hill, on Friday and Saturday, April 26 and 27. Dr. H. V. Wilson is president and Dr. E. W. Gudger secretary.

THE Philosophical Institute of Canterbury, New Zealand, which came into existence on August 30, 1862, will celebrate its jubilee this year. It is proposed to mark the occasion by holding a gathering in Christchurch.

MESSES. CONSTABLE AND COMPANY announce the publication, beginning in April, of a new quarterly review to be called *Bedrock*. The acting editor is Mr. H. B. Grylls, and there is an editorial committee consisting of Sir Bryam Donkin, Professor E. B. Poulton, Dr. G. Archdall Reid and Professor H. H. Turner.

THE American Museum of Natural History has secured, through the generosity of Mr. J. P. Morgan, Jr., the collections of minerals and meteorites left by the late Stratford C. H. Bailey, of Oscawana-on-Hudson. Mr. Bailey had been an indefatigable collector for many years and had assembled representatives of nearly three hundred falls and finds of meteorites, at least twenty-one of which are new to the museum's already great foyer collection.

EXTENSIVE infection of the San José scale has been discovered on trees in the southern part of Wisconsin by Professor J. G. Sanders, of the University of Wisconsin. Professor Sanders, who is also state nursery inspector, reports that steps are being taken to control the pest and prevent its spreading beyond the area affected already.

THE return of the *Terra Nova* brings from the British Antarctic Expedition news of importance, if not as exciting as that from Amundsen. Captain Scott, who was nearing the South Pole at the latest report, remains another year to complete his scientific work, which should be a valuable contribution to polar knowledge. The magnetic, meteorological and biological observations will form welcome additions to those of previous explorers. Those in geology will probably prove to be of primary value. Near Granite Harbor have been discovered marble, topaz, fossils (probably Crustacean it is said), and coal of

economic value. Two species of wingless insects were found in large numbers, and are an unexpected addition to Antarctic fauna. Scientific men will await with interest the detailed report on the fossils, with their reference to, or connection with, the Antarctic specimens from Seymour and other islands to the east of Palmer Land. It will be recalled that Larsen, in 1892 and 1893, brought from Seymour Island, petrified wood and mollusca. In 1902 Professor Otto Nordenskiöld very greatly increased knowledge along these lines. His collections from Seymour, Snow Hill and Cockburn Islands were rich in types of the Jurassic system. Among fossils discovered by him were beeches, cycads, ferns, firs, pines ammonites, etc., and of giant penguins, seven feet tall, considerably larger than the emperor penguin of to-day.

THE *Carnegie*, in command of W. J. Peters, arrived at Manila early in February and is now *en route* to Suva, Fiji Islands. From thence she will proceed to San Diego, California, instead of Acapulco, Mexico, as originally announced. Besides Mr. Peters, the present scientific personnel consists of Dr. H. M. W. Edmonds and Messrs. H. D. Frary and H. F. Johnston. Dr. N. E. Dorsey, Ph.D. (Hopkins, '97), has resigned his position as associate physicist in the United States Bureau of Standards, having been appointed research associate in the department of terrestrial magnetism of the Carnegie Institution of Washington. He will have charge of special experimental and theoretical work, in which he will be assisted by Dr. R. H. Galt. Mr. E. Kidson continues the general magnetic survey of Australia. The following have been appointed magnetic observers: D. W. Berky, for work in northwest Africa with Mr. W. H. Sligh; Donald Mackenzie and H. R. Schmitt, members of Mr. J. P. Ault's party in Peru, Bolivia, Paraguay and Uruguay; C. W. Hewlett for ocean observational work aboard the *Carnegie*, beginning at San Diego, and A. D. Power. Professor H. D. Harradon, A.B. (Bates, '06), has been appointed translator and librarian.

THE University of the Philippines and the Bureau of Science will combine this year to inaugurate a marine biological survey of the Philippines. The party to take the field will be composed of Mr. Alvin Seale, chief of the division of fisheries, Bureau of Science, Dr. Lawrence E. Griffin, associate professor of zoology, University of the Philippines, Dr. Reinhart P. Cowles, assistant professor of zoology, Mr. Lawrence D. Wharton and Mr. S. F. Light, instructors in zoology, and three Filipino assistants. The station this year will be at Puerto Galera, a small harbor on the northern coast of Mindoro, where marine life is extremely abundant and the facilities for collecting observations are unusually fine. The party will be in the field about three months.

A STATION for instruction and research in biology will be maintained by the University of Michigan, for the fourth season, as a part of its regular summer session during the eight weeks from July 2 to August 23 inclusive, 1912. The station will be located near the Bogardus Engineering Camp of the university on a tract of about 1,666 acres of land owned by the university and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. This region, diversified by hills and valleys, was formerly covered by forests of hardwoods and conifers. Small tracts of the former still remain. It contains many lakes of clear water, unsurpassed in the state for size, depth and beauty of setting. The elevation of the camp, between one and two hundred feet above Lake Michigan, insures cool nights. The staff of instructors includes Professors Jacob Reighard, Frank Smith and Henry Allen Gleason, and Drs. A. F. Shull and R. M. Harper.

THE ninth annual session of the Puget Sound Marine Station will convene at Friday Harbor, Washington, on June 24, and will continue for a period of six weeks. The plant has been considerably augmented so as to provide facilities for an increase in attendance over the session of 1911, when nearly one

hundred persons were present at the station. The courses to be offered are as follows: Algology, H. B. Humphrey, Washington State College; Systematic botany, A. R. Sweetser, University of Oregon; Elementary zoology, W. A. Redenbaugh, Seattle High Schools; General ecology, H. S. Brode, Whitman College; Embryology of invertebrates, W. J. Baumgartner, University of Kansas; Ichthyology, E. V. Smith, University of Washington; Advanced ecology, Trevor Kincaid, University of Washington; Plankton, John F. Bovard, University of Oregon. Facilities will also be offered for research work along botanical and zoological lines. The systematic survey of the local fauna which has been in progress for several seasons will be continued by further deep water exploration. The director of the station, Professor Trevor Kincaid, of the University of Washington, will be glad to give more extended information to persons planning to visit the laboratory.

UNIVERSITY AND EDUCATIONAL NEWS

THE Maryland legislature has voted the sum of \$600,000, to be followed by an annual grant of \$50,000 to establish a school of technology in connection with the Johns Hopkins University.

A GIFT of \$300,000 to Princeton University from Mr. William Cooper Proctor, of Cincinnati, for the endowment of the Charlotte Elizabeth Proctor fellowships in the graduate school is announced. Mr. Proctor, who had previously given \$500,000 to the graduate school, was elected a life member of the board of trustees to succeed Mr. Cleveland H. Dodge, of New York, who resigned last autumn.

MR. E. C. CONVERSE, of New York City, has given \$125,000 to Harvard University for the establishment of an Edmund Cogswell Converse professorship of banking in the graduate school of business administration. The university has also received \$23,000 from Mrs. J. K. Paine, for the establishment of the John Knowles Paine fellowship in music.

THE University of Chicago has established a system of retiring allowances for professors

or their widows. A fund of \$2,500,000 taken from the \$10,000,000 Rockefeller gift of 1910 has been set aside for this purpose. This pension system will grant to men who have attained the rank of assistant professor or higher, and who have reached the age of 65 and have served 15 years or more in the institution, 40 per cent. of their salary and an additional 2 per cent. for each year's service over 15. The plan also provides that at the age of 70 a man shall be retired unless the board of trustees specially continues his services. The widow of any professor entitled to the retiring allowance shall receive one half the amount due him, provided she has been his wife for ten years.

MISS ROSA MORRISON, for nearly forty years superintendent of women students of University College, London, has bequeathed \$20,000 to the college to establish scholarships in English and German.

THE thirty-eighth annual commencement of the Colorado School of Mines will be held on May 24, when fifty-two graduates will receive their degrees. The address of the day will be given by Mr. William Lawrence Saunders, of New York, president of the Ingersoll-Rand Company.

DR. E. I. WERBER, assistant in anatomy at the Johns Hopkins University, has been appointed instructor in anatomy at the University of Wisconsin.

DR. DURANT DRAKE, of the University of Illinois, has been appointed associate professor of philosophy at Wesleyan University.

DR. JAMES A. BABBITT has been promoted to professor of hygiene and physical education at Haverford College.

MR. C. M. GILLESPIE, of Yorkshire College, has been appointed to a newly established professorship of philosophy at Leeds.

DISCUSSION AND CORRESPONDENCE

A DEFENCE OF THE "NEW PHRENOLOGY"

ALTHOUGH I am not a partisan of the traveling phrenologist, I am a believer in cerebral localization or, putting it in more general

form, in the localization of functions in the central nervous system. If we must make a choice between phrenology (supposing for the moment that phrenology is equivalent to localization of function), and the conception that mental processes are something transcending cerebral organization and cellular processes, then I am a phrenologist. It is evidently in this latter sense of localization that Professor Franz¹ uses the term "new phrenology."

It is true that Marie and von Monakow have shown that certain of the more or less current conceptions of focal or insular representation of cerebral function, particularly those concerning the speech center, are no longer tenable, but neither Marie nor von Monakow has denied that certain definite fibers arise from definite circumscribed areas of cells in the cerebral cortex and run to certain definite end stations. Indeed, no point of nervous anatomy or physiology seems better established than this. And stimulation of a definite, circumscribed area of the cerebral motor cortex of any one animal always elicits a response of a definite group of muscles, and never of any other groups. This definite, circumscribed cell area constitutes the focal or insular motor representation in the cerebral motor cortex of this particular group of muscles. Such a circumscribed area, frequently marked off from surrounding cells by a boundary of non-nervous tissue, is commonly known as a motor center.

It would however be an error to suppose that this group of cells is an isolated group. It has, through afferent association neurones, connections with practically every portion of the cerebral hemisphere of the same side; through commissural neurones, with practically every portion of the opposite side, and through afferent projection neurones, it is brought into relation, directly or indirectly, with the cerebellum, spinal cord and other structures. The circumscribed area of cells thus becomes a part of an extremely complex and extensive *motor system*, but in such participation it

¹ SCIENCE, 1912, N. S., XXXV., p. 321.

loses nothing in definiteness of location or of function. The conception of a circumscribed motor center must be superseded by the conception of a motor system or mechanism. It is to such a mechanism that we may apply the conception of integration as developed by Sherrington. Integration is essentially a dynamic rather than a morphological process; but integration implies a certain definiteness of relationships, morphological as well as dynamic, throughout any one process. We have already stated that stimulation of the particular group of cells always evokes a response of a particular group of muscles—contraction of one set and relaxation of their antagonists. And since this phenomenon of group movement is constant from day to day or year to year in any one individual, we are justified in assuming that a certain rather constant morphological mechanism integrates certain rather constant relations in time and space to a fairly constant result. This is the essence of the modern dynamic view of localization of function.

Let us apply this conception to the solution of one of the problems which puzzle Professor Franz. He cites the experiments of dividing two motor nerves and suturing the central end of one to the peripheral end of the other, with the subsequent recovery, after a period of paralysis, of movement in the respective groups of muscles supplied. The regeneration of the nerves undoubtedly means that muscle group *A* is now innervated by fibers arising from cells in the area which previously supplied muscle group *B*. There is no necessity for postulating any further anatomical change, and no basis in fact for such a postulate, even if it were necessary, since no new nerve cells arise after birth in the forms used for the experiment. We must seek an explanation, either in the relationships of the cells and their life processes, or in the entrance of some psychic or mental factor (and hence on Professor Franz's own argument, some unknown factor so far as its localization is concerned) into the readjustment.

Fortunately, the relationships of the cells and their life processes offer us some hope of

a solution. We have already mentioned the fact that the cellular insula is in relation with practically every other portion of the same cerebral hemisphere, and we should emphasize the fact that the response of the motor cells is determined largely by these afferent impulses. In the absence of afferent impulses from the muscles to which they send fibers, the motor cells cause an uncertain and inaccurate response. The mechanism of integration, while not completely wrecked, is damaged and rendered inaccurate. In the process of regeneration of the severed nerves, the sensory (in case it was previously interrupted) as well as the motor connection of the muscle with the cortex has been restored. Impulses coming in over the old sensory route and reaching their usual motor cell destination in the cortex will now produce confusion of motor response. But the ocular path is open and the animal sees its limbs. An animal which has lost all sensation in a limb, through section of the sensory roots, becomes able to control the movements of the apæsthetic limb through its visual mechanism. When the eyes are bandaged, the motor embarrassment of the apæsthetic limb returns. (Bickel.) The ocular path affords one possible, and probable, explanation of the return of motor function in the muscle groups whose nerves were severed. But the possibilities of recovery after transposing and suturing the nerves are by no means exhausted. The afferent impulses from the muscles do not reach their motor cell destinations over one neurone, but over a series of neurones. Between the cortical termination of the afferent path and the motor cells, there are intercalated association neurones. In the early period of recovery the confusion caused by the access of afferent impulses to the wrong motor end station produces an unusual stress in that particular region, and impulses may flow over previously unused channels, thereby eventually reaching, more or less indirectly, the proper destination. The final condition of equilibrium in the system will be reached when the association path from afferent cortical ending to the proper motor cell comes to be the one most

easily followed. The experiment of transposing and suturing motor nerves is successful only when nerves whose central terminations are relatively close to each other are used for the purpose. I am inclined to regard the sensory readjustment as essentially a dynamic rather than as an anatomical change.

This is only a simple case, and the physiologist does not get very far in his experiments without encountering more serious difficulties. In the higher vertebrates the situation is further complicated by the presence of two motor systems—the phylogenetically old and the phylogenetically new, *e. g.*, the pyramidal tract, as von Monakow² has pointed out on morphological grounds and as I have indicated (1909) from experimental considerations. In case of injury to any part of the newer system, the phylogenetically older system may assume, in a certain degree, the functions previously belonging to the newer system. The theory of localization of function in its relation to the phylogenetic development of the nervous system enables us to give a rational and intelligible account of many nerve processes, though the lack of experimental data leaves others unilluminated. It is but fair to state in this connection that the only physiologist of modern times who maintained a perfectly consistent attitude on cerebral localization was Goltz, who denied it in toto.

It follows, as a consequence of the postulate of integration, that the character of the activity of any particular mechanism is determined, not by any one constituent part, but that the final action is the sum of the activities of the various constituent parts. A change in the relation of the afferent impulses produces a change in the motor reaction. Indeed, we may probably say that if all the relations are the same in two successive processes, even though they may be separated in point of time, the motor reactions must necessarily be alike. This is certainly true of some reactions, and may be regarded as a restatement of Hermann's law of specific re-

sponse to stimulation, and is in line with C. O. Whitman's wider generalization that "organization shapes behavior."

The theory of integrative action may be extended to the field of the special senses. The psychologists, or certain of them, have argued that, since neither the afferent nerves of special sense nor the central cells about which they terminate are sufficiently different anatomically from other afferent nerves or central cells to explain the specific energy of the sensory nerves, this difference in sensation must depend upon consciousness. In this they have been but miserable comforters. Since no one has yet told us what consciousness is, attributing a certain function to consciousness is tantamount to saying that we know little about it. If the ultimate sensation of which we become aware is due not to a single afferent nerve and a circumscribed end station alone, but to the peculiar relationships of these structures to other parts of the nervous system as well, the aspect of the problem changes somewhat. The visual sensations, for example, may be the resultant of afferent impulses over the optic nerve acting on various central stations, some of which, as shown by the course of the association tracts, may be remote from the occipital area of the cerebral cortex. If a particular sensation is the result of the action of a definitely localized integrating mechanism, consciousness, in so far as it deals with this particular sensation, is also a result of the activity of a definite organization, morphological and functional, of the brain, and is related to a fairly definite region or regions. It is doubtful whether the psychologists are in possession of sufficient facts to show that such a hypothesis of integration is impossible or even improbable. Few physiologists will deny that our analysis of the motor system and, *a fortiori*, of the system of the special senses, is incomplete, and that we do not yet know all we need to know about them. Few will deny that the analysis is difficult, and that we may be a long time finding out. I am free to admit the possibility that the views stated here may not be the final views in the matter. I am ex-

²"Aufbau und Lokalisation der Bewegungen beim Menschen," Leipzig, 1910; "Über Lokalisation der Hirnfunktionen," Wiesbaden, 1910.

tremely loath to admit that the analysis of the motor and sensory systems is impossible, or that it will finally be necessary to postulate any agency which transcends matter and energy as we ordinarily know them, to complete that analysis. I would strongly insist that even our present methods of analysis have not as yet been shown incapable of yielding further information. I am not quite sure, from reading Professor Franz's paper, of his position in regard to localization of the motor system, or of certain sensory systems, but I have given this survey of them in order better to show by comparison, that similar methods may be applied to the analysis of mental processes.

For my part I find it impossible to gain a clear idea of how the brain functions as a whole in motor processes. I do believe, however, that we may gain a certain degree of clearness of ideas if we suppose that certain definite circumscribed cell areas, and no others, acting through their association tracts, may evoke a definite motor reaction, and no other motor reaction. Similarly, I find it extremely difficult to see how the brain, acting as a whole and without reference to circumscribed cerebral areas or to integration systems involving two or more such areas, may give rise to a mental process. I can picture to myself a conceivable way in which several cell groups or systems, acting together in a particular manner and without special reference to the rest of the brain, may give rise to a particular mental process or conception made up of certain definite mental elements which are related in a definite way. Other parts of the brain may subsequently be involved in succeeding mental processes, but a definite order of succession may well be followed. This is, as I take it, the only fundamental difference between Professor Franz and the advocates of cerebral localization. It appears to me that the localizationists, or phrenologists if you please, have somewhat the better of the argument, inasmuch as one very valuable method of getting at the working of a mechanism as a whole is by taking it to pieces and studying the properties and reactions of each

piece separately, and attempting to determine the relations of the pieces to one another. The validity of each view must, however, be determined by the results which it can produce when applied to the analysis of nervous functions.

To many of us, mental states mean the resultant of the various sensory impressions of the moment, modified, it may be, by stored-up impressions of past incidents—the memory of past sensory impressions. To many of us, it appears, also, that sensory impressions are closely connected, in a dynamical way, with certain definitely localized anatomical mechanisms in the central nervous system. If it be true that there exist in the central nervous system such integrative sensory mechanisms, and if it also be true that mental states are but the integration, in a definite sequence in space and time of these sensory impressions, it follows that there must also be localization of mental processes with reference to these integrative mechanisms. It may be that our views of definitely localized integrative mechanisms and their functions are unfounded, but they appear to be the simplest views which, in the light of our present knowledge, we are justified in retaining.

This is not to insist that any one shall become a new phrenologist against his will, but is meant simply as a justification for those to whom it still appears that localization of function, in the sense of its dependence upon the action of localized integrative mechanisms, "is a wholesome doctrine and very full of comfort."

F. H. PIKE

DEPARTMENT OF PHYSIOLOGY,
COLUMBIA UNIVERSITY

MR. DOOLEY ON SCIENCE: BEING A PROTEST AGAINST
THE VIOLENCE OF THE GENETICIST

"SCIENCE is a great thing, Hinnissy," said Mr. Dooley. "Av coorse t' a man av yer onidjicashun th' rale progriss iv science manes but little, but to thousands iv collidge profissors 'tis the brith av life. Av coorse 'tisn't much iv a livin' the pore divils git, but th' likes iv them don't nade t' spind money like you and me—them havin' no bad habits."

"But what do their families do?" asked Hennessy.

"They don't have anny," said Mr. Dooley.

"Yis, science is a great thing."

"But what is science?" said Hennessy.

"I'm serprised at yer ign'rince, Hinnissy. 'Tis 'knowledge sit in orther,' as me frind Doc Wiley says. It's like this. Take yerself, Hinnissy; ye have some knowledge iv mixin' drinks, but it kapes ye in trooble because ye don't have it sittin' in orther."

"I orther what I plase," said Hennessy.

"Don't intrupt me argiment," said Mr. Dooley. "Yer knowledge bein'—as I may say—th' common or gardin varity iv knowledge, ye george yerself on two scooners iv beer and thin ye regeorge yerself on two indacintly large glasses iv whiskey, and thin I have to iscoort ye home."

"Niver! with only two glasses," interrupted Hennessy.

"As I was sayin', 'tis th' orther was wrong. That's where science stips up and puts ye right. It says, the orther is beer afther whiskey; niver whiskey afther beer."

"Do ye know anny scientists?" said Hennessy.

"Some iv th' greatest," replied Mr. Dooley. "In fact, I have jist coom from visitin' wan iv me old collidge frinds, who is a great beollergist. As I know that ye can't consave th' proper manin' iv th' worrurd Beollergist, I will explain. 'Tis made up iv two worrurds, the worrurd 'be,' 'being,' manin' annything at all that can be, and th' worrurd 'oller' or 'holler.' That is, 'tis anny wan who hollers a great deal about ivry livin' thing."

"Where does yer frind worruk?" asked Hennessy.

"Niver say that worrurd iv a scientist, Hinnissy. He re-e-tains a posishun iv thrust an' responsibility with our great an' gloryus government at Washington."

"Do they have scientists at Washington?" asked Hennessy.

"They do that. Me frind says that moostly all iv th' raly progrissiv scientists ar' at Washington. Ye see, Hinnissy, scientists ar' jist like polytishuns; they ar' divided into pro-

grissives an' consarvitives. The progrissives want to see somethin' doin' avin av they have to do it thimselves; th' consarvitives moost have ivrythin' quiet avin iv th' ither want t' worruk."

"What do they do?" said Hennessy.

"They ask Congriss fer large appropria-shuns froom th' money that th' taxpayers iv th' coontry rejoice t' conthribute, fer th' perpus iv amelyoratin' th' rejuiced condishun iv th' pore farmer."

"What ilse do they do?" asked Hennessy.

"I fergot t' ask," said Mr. Dooley, "but I know, be th' way me frind was wipin' th' sweat iv toil from his brow, that he is not wan who wud accept his small honyrarium from a ginerus an' grateful government without doobly arrnin' it. He had jist finished, be tremenjus la-a-bor, a monimental worruk showin' how anny farmer, be th' simple use iv a tilliscope an' siv'ral ither chemicals which have iscaped me mim'ry fer th' moment, can ixamine a single grane iv wheat an' tell what farm it grew on."

"Why shud he want to do that?" said Hennessy.

"He don't," said Mr. Dooley as he relighted his pipe, "but it will amelyorate his rejuiced condishun."

"But it was not this awful la-a-bor brot to a brilyunt conclushun that pre-e-juiced th' beads upon his fevered brow; it was th' great trooble he was havin' to kape th' science iv th' coontry upon 'th' plane to which it properly belongs,' as he said to me in toones iv great imotion. Says he: 'Iv'ry time I pick up me fav'rite jernul, *The Expirimint Stashun Ricord*, I am pained be th' use iv langwidge that I do not understand. There ar' worrurds that I have always trated as me own chilther that wud no longer be ricognized be their own father.'

"Not wishin' to seem onint'risted I bro-o-ke th' pause in th' convarsashun be askin', 'Ain't there lots iv worrurds with more than wan manin'?'"

"'In litherachoor,' says he with a savidge frown, 'which is a very diff'runt thing. In litherachoor such a thing is permisabul be-

cause only orthinary onint'ristin' persons read litherachoor. In science wan must be ortherly. Iv'ry scientist has an ortherly brain an' becomes confused in his finer sinsibilities av a worrud has mo-ore than wan manin.' We shall have a law passed forbididin' th' use iv anny worrud in anny but the proper meanin'."

"How will ye know th' proper manin'?" says I, bein' somewhat puzzled.

"The proper manin' iv anny worrud,' says he, 'will be th' manin' which I and me brothers iv like int'rists and progrissiv ideas will give it.'

"Who are th' villuns who have bin committin' this abuse iv will intinshuned worruds?" I asked.

"They raly shud not be called scientists at all,' says he, 'but sudo- or false scientists. They call thimselves "geneticists." 'Tis a worrud that means an investigator in th' sudo-science iv heredity. But whin th' law is passed,' says he, 'twill be a mame iv great approbrium.'

"I shud think the name wud be curse enuf,' said I. 'But what is the precise branch iv th' great realm iv knowledge that they st-thrive t' be settin' in orther? What is th' rale manin' iv it?'

"They ar' th' scounthruls,' says he bitin' a large pace out iv a pincil he was holdin', 'that ixamine yer eyes an' th' eyes iv yer wife—an' th' eyes iv yer parents barrin' they ain't iscaped be dyin'—an' tell ye what color they will let th' eyes iv yer chilther be.'

"What av ye rafuse t' ixcept th' color they pick out fer ye,' says I.

"Ye have to,' says he.

"The villuns,' says I agin, fer be this time I was beginnin' t' see th' foul plot against th' liburties iv our great nashun. 'It must be stopped.'

"It will be,' says he. 'Ler goose a broila, as that prince iv awthirs Bill Shakespere or soome wan ilse has so will said. No more will they be allowed to fill th' chickest jernuls wid mistakes, conthradicshuns and maledicshuns concarnin' mathematics iv which they know nawthin', an' concarnin' beollergy av which they know less.'

"But don't all conthribushuns to th' larned jernuls soometimes contain mistakes?" says I.

"All but those iv meself an' a few ithers,' says he.

"How do ye manage it?" says I.

"We don't conthribute annythin',' says he.

"Have ye spoken to me frind Doc Wiley about this attack upon th' bulworruks iv a great people?" says I.

"I have written him th' full details,' says he, 'but I'm afraid he has proved false to th' thrust th' people have reposed within him.'

"What did he say?" I exclaimed in horror.

"Here is his letter,' says he.

"My Dear Sir: I fear yer liver is out iv orther. I wud advise you to take Hg.Cl, wantin' grain iv'ry fifteen minits fer four hours. N. B. Be sure an' rimimber the 2 afther the Hg, fer anny misuse iv sich a worrud or char-a-ther might cause wan iv yer inimies t' be indited fer yer desace."

"Wud he pisen ye?" says I.

"I don't know,' says he, 'I didn't take it.'

"I'm not sure that I know what it's all about," said Mr. Hennessy, "but it must be a grand thing t' be a raly great scientist. I shud like to be wan."

"Fergit it," said Mr. Dooley, "th' great wans ar' all dead."

A. P. SEUDO,

With apologies to P. F. Dunne

SCIENTIFIC BOOKS

RECENT BOOKS ON THE DOCTRINE OF DESCENT

La genèse des espèces animales. By L. CUÉNOT. Paris, Felix Alcan. 1911.

Allgemeine Vererbungslehre. By V. HAECKER. Braunschweig, Friedr. Vieweg und Sohn. 1911.

Heredity in Relation to Evolution and Animal Breeding. By WILLIAM E. CASTLE. New York, D. Appleton & Co. 1911.

Upon the Inheritance of Acquired Characters. By E. RIGNANO. Authorized English translation by BASIL C. H. HARVEY. Chicago, Open Court Publishing Co. 1911.

These four books have one feature in common, namely, they all deal with problems

which lie at the base of the doctrine of descent. But while they present this similarity they also differ greatly in their scope and manner of presentation, the first covering the broader field of the origin and adaptation of species, the second reviewing carefully and thoroughly our present position with regard to the fundamental facts and theories of heredity, the third presenting in a more popular manner the principles of Mendelian inheritance, while the last is an exposition of a new theory of heredity.

Professor Cuénot's book is one of the International Scientific Series, and in many ways it recalls one of the same series published thirty years ago and still a treasury of pertinent facts for the modern zoologist, Semper's "Animal Life." It endeavors to present impartially the important facts upon which the conclusions of zoological investigation are founded, rather than a minute exposition or criticism of these conclusions. The first part is a brief statement of the growth of the doctrine of transformism and to this succeeds a study of the phenomena of reproduction, form regulation and correlation, animal behavior and sex differentiation, and finally, the duration of life of the individual is considered.

The third part is devoted to the conditions under which variation of the individual occurs, under which heading are considered the phenomena of mutation (the Mendelian phenomena being included under that caption), the non-inheritance of acquired characters and selection, and then follows a fourth part devoted to geographical distribution and the faunistic characteristics of the various milieux, marine, aquatic and terrestrial. In this part one finds brief, interesting discussions of the planktonic, littoral and bathysinal faunas, together with those of brackish and supersaline waters, mountain regions and caves and, finally, there is a brief discussion of commensalism and parasitism. The fifth and last part presents, first, a brief statement of the doctrine of panspermia maintained by Montlivault and Arrhenius, and proceeds with a discussion of the origin of species and adaptations in which such phenomena as iso-

lation, parallelism, polymorphism, regression, protective and warning coloration and mimicry are illustrated by well-chosen examples. A brief exposition of the views of Lamarck, Darwin, Eimer, Weismann and the post-Darwinian schools rounds out a satisfactory concrete exposition of what may be termed the principles of general zoology. Notwithstanding the conciseness necessary in a work covering so wide a territory the book is most readable and interesting, and, with its extraordinary wealth of well-chosen examples and its abundant illustrations, will prove a boon both to the teacher and the student of general zoology.

Haecker's "Allgemeine Vererbungslehre" has more of an academic character, being the outcome of lectures delivered by the author in past years at Stuttgart, Hohenheim and Halle, and will be welcomed by professional zoologists as a thorough scientific exposition of our present knowledge of the underlying principles and laws of inheritance. Starting with a brief historical section, in which Galton's law is discussed, the morphological bases of heredity are considered with a thoroughness and clearness that are admirable, the author's experience with cytological phenomena as seen in copepodan germ cells rendering him especially at home in this part of his subject. Of especial interest are the discussions of heterotypic mitoses and heterochromosomes and of the significance of the number of chromosomes. The third section is of a more theoretical nature, being devoted to a review of Weismann's hypotheses and Hertwig's theory of biogenesis.

The fourth section is a return to the descriptive side of the subject, the phenomena of Mendelian inheritance being under consideration, and receiving a remarkably clear presentation, excellently illustrated. In the concluding section theoretical considerations, such as the individuality of the chromosomes, the reduction division and the determination of sex are again prominent, and the last chapter is devoted to the discussion of a Kernplasma theory of heredity to replace the chromosome theory.

Haecker's book by reason of its thoroughness and scientific method of exposition will undoubtedly be to a large extent caviare to the general, but that by Castle will appeal to a much wider circle of readers as a clear and direct statement of the Mendelian principles and their application, couched in language as simple and untechnical as may be. Its title, compared with that selected by Haecker, is perhaps a little misleading, for the book is limited to an account of the Mendelian phenomena and their formal explanation. The cytological side of inheritance, so prominent in Haecker's book, is barely considered; indeed, it could hardly be expected in a book written for the general reading public. Taking into account the limitations set by its purpose, the book is an excellent presentation of the Mendelian phenomena, based upon studies extending over some ten years, and while the general reader may in some cases find it difficult to follow the complexities of the phenomena, yet he will not fail to form an intelligent appreciation of the far-reaching significance of Mendelism.

But it is not to the lay brother alone that the book will prove of interest. The expert will find much to interest him in its logical methods and in the *résumé* it presents of extensive experience in experimental breeding, and in certain of the chapters, such, for instance, as those on Mendelism and Selection and on Heredity and Sex, he will be rewarded with no scanty supply of food for thought.

Rigano's work appeared in a French edition as long ago as 1907 and an abstract of it by the present translator was published in *The Monist* in 1909. It is an attempt to formulate a new theory of heredity based on analogy with certain electrical phenomena. The theory of centro-epigenesis, as it is named, assumes the existence in the germ plasma of certain specific potential elements, which send out in succession through the organism impulses which determine the various stages of its ontogeny, each specific impulse depositing in the nucleus of the cells to which it passes a definite substance, which, under similar con-

ditions is again capable of producing the same specific impulse as that by which it was deposited. When ontogenesis is complete the organism is in a state of dynamic equilibrium so far as the epigenetic impulses from the germ plasma are concerned, but it is now receiving functional stimuli, which in a similar manner produce specific impulses leading to the deposit of what may be a new kind of material. If the stimulus reaches the germ plasma new specific potential elements will be deposited in it and so the way is open for the inheritance of acquired characters.

This is a bald statement of the essentials of the theory which is fully elaborated and compared with rival theories in the volume under consideration. Similarities with Semon's theory of mnemes suggest themselves, and like this the theory can truthfully be said to be exceedingly suggestive. But if criticism may be made without entering into details, it would seem that centroepigenesis explains almost too much, in furnishing possibilities for the inheritance of acquired characters far beyond what reality demands. It is based on assumptions which at present we have no means of either proving or, what is much more difficult, disproving, assumptions drawn from what is not always a reliable source, namely from analogy. But right or wrong, it should serve to suggest lines along which the further investigation of the physiology and physics of the developing organism may advantageously proceed.

The translation, it should be stated, is well done and the translator is to be congratulated on having supplied English readers with an accurate and readable statement of the theory.

J. P. McM.

Nephritis, An Experimental and Critical Study of its Nature, Cause and the Principles of its Relief. By DR. MARTIN H. FISCHER. (The 1911 Cartwright Prize Essay of the Association of the Alumni of the College of Physicians and Surgeons, Medical Department of Columbia University, New York.) First edition, large 12mo. Pp. ix + 203;

31 figures, including a colored plate. Cloth, \$2.50 net. New York, John Wiley & Sons. 1912.

In this book Fischer has made a special application to the kidney of the same standpoint, principles and methods as were used in the more general discussion contained in his work on edema, published two years ago. According to his view it is to the colloidal properties of albuminous substances, and particularly of such bodies in the *jel* state, that we must look for an explanation of many phases of the behavior of living cells, not only in health, but to an equal degree in disease. In particular the amount of water contained within every cell, *i. e.*, its turgescence, and the extent to which the cell membrane dissolves, passing from the *jel* to the *sol* condition in the surrounding fluids, are determined by the properties peculiar to colloids. These properties, as we find them in the so-called emulsion or lyophilic colloids to which all albuminous substances belong, include a specific avidity for water according to the conditions under which the colloid is placed. Thus if a piece of dry sheet gelatin is placed in water at an ordinary temperature it swells—that is, imbibes water—to a fairly definite degree. Similarly in the *sol* condition, as in the case of the proteins of the blood plasma, the water in which they are said to be “dissolved” is really held by the colloid. Otherwise the tissues of the body should immediately imbibe all of the blood fluid as they do saline or Ringer’s solution. The avidity of the colloids for water is, however, subject to great alterations according to the surrounding conditions. Thus acids and alkalis both induce a markedly increased degree of swelling as compared with a neutral watery medium, while salts, on the contrary, tend to decrease the capacity of colloids to take up and hold water. As the result, in particular, of the work of L. J. Henderson it is now known that the normal blood is not only neutral in reaction, but that it has a remarkable capacity to maintain its neutrality against the introduction of considerable quantities of acids or alkalis. Under the influence of toxic substances, or under conditions in which the

circulation is interfered with, a formation and accumulation of acids within the tissues of an organ does, however, occur. This is particularly the case in an organ which, like the kidney, has normally a large respiratory exchange.

Boldly following this conception to its conclusion Fischer holds that “all the changes that characterize nephritis are due to a common cause—the abnormal production or accumulation of acid in the cells of the kidney. To the action of this acid on the colloidal structures that make up the kidney are due the albuminuria, the specific morphological changes noted in the kidneys, the associated production of casts, the quantitative variations in the amount of urine secreted, the quantitative variations in the amounts of dissolved substances secreted, etc.” In support of this thesis experiments are reported in which a typical cloudy swelling was induced in thin sections of fresh kidney tissue when placed in dilute acid. Similarly in experiments upon animals injection of acid into the blood stream is quickly followed by a marked albuminuria. The same result follows temporary ligation of the renal blood vessels. On the other hand—and herein, perhaps, lies the most important points of Fischer’s investigations—if under conditions in which nephritis would otherwise occur an increased quantity of neutral salts is brought into contact with the tissues, the effects of acid may be completely counteracted, and the kidney restored to practically normal structural appearance and functional behavior. Thus, “Sodium chloride when injected intravenously, in concentrated solution, simultaneously with hydrochloric acid solution of a concentration which we found in other experiments to lead to the symptoms of a most intense acute nephritis, practically suppresses this entirely. The albuminuria scarcely appears, and there are no casts, no red blood corpuscles, no hemoglobinuria, no decrease in the amount of urinary secretion, and no general edema.” Finally Fischer reports a number of clinical cases of nephritis, some of them with complete anuria and coma, in which a rapid recovery was in-

duced by the administration per rectum of a solution of NaCO_3 and NaCl .

From the foregoing outline it will be seen that this book is in no sense the conventional restatement of pre-existing data and current opinions. On the contrary, it is a highly original thesis. From those hide-bound critics, who resent whatever is unorthodox, it will probably elicit more dissent than approval. This has always been the price exacted by such critics from those who are ahead of their time. They objected to Fischer's preceding work on "Edema" on the ground that "there are some facts which it fails to explain." They will find that the same criticism can be made of the present monograph. There are indeed some points in the book upon which one must hope that the author will later bring forward fuller evidence. Nevertheless, if, as seems but fair, a new idea is rather to be approved for the points which it illumines than condemned for those which it leaves in obscurity, this work should be welcomed and studied. It holds out suggestions which may prove of great practical therapeutic usefulness. On the theoretic side there is a wide range of phenomena, previously obscure, upon which it throws a brilliant light.

YANDELL HENDERSON

An Experimental Study of the Death-Feigning of Belostoma (= Zaitba Aucct.) fumineum Say and Nepa apiculata Uhler. By HENRY H. P. SEVERIN, Ph.D., Professor of Entomology, College of Hawaii, and HARRY C. SEVERIN, M.A., Professor of Entomology, South Dakota State College of Agriculture and Mechanic Arts. Cambridge, Boston, Mass., Henry Holt and Company. 1911. Pp. iii + 47, with one plate.

This excellent piece of experimental work forms one of the series of "Behavior Monographs," that are being published in connection with *The Journal of Animal Behavior*, being Number 3, Serial Number 3, Volume I.

There is, perhaps, no more curious and interesting form of instinctive response than that represented by the death-feigning reac-

tion among insects. It has been a matter of considerable discussion among students of animal activities for many years. There has been no piece of work of this nature published for some time which so thoroughly treats of this peculiar form of behavior, by the experimental method—unless we consider that of Holmes on *Ranatra*.

The major headings of the table of contents will largely indicate the nature of the monograph: I., Introduction; II., General Characteristics of the Death-Feint; III., Duration of Successive Death-Feints; IV., The Effect of Dryness and Moisture on the Duration of the Death-Feint; V., The Effect of Temperature on the Duration of the Death-Feint; VI., The Effect of Light on the Duration of the Death-Feint; VII., The Effect of Mutilation on the Death-Feint; VIII., The Origin and Development of the Death-Feint; IX., The Psychic Aspect of the Death-Feint; X., Summary.

II. It is shown that the "death-feigning" postures of *Belostoma* are decidedly characteristic. However, the positions assumed during the feint are unlike those of the dead insect. The response may be elicited by simple contact; as, for instance, when it is dipped out of the water with the net; or when it is picked out of the aquarium by hand. Some individuals do not feign death readily; in such cases, repeated touching of the posterior part of the abdomen will cause the organism to respond with the death-feigning reaction. *Nepa* feigns death either in the water or out of it. Here again contact seems to be the important stimulus. *Nepa* will even feign death when feeding, the creature "keeping the styliform mandibles and maxillæ sunk into the prey." Detailed descriptions are given of the positions of the various appendages during the feint, both in the case of *Belostoma* and *Nepa*. While the former assumes a characteristic posture, *Nepa* will feign death with the appendages in the same position as taken just previous to the death-feint. During the feigning period, the muscles of *Belostoma* are in a condition of "extreme tetanus." *Nepa*

may be held by any tibia or femur in such a manner that the weight of the entire insect is sustained by the extensor muscles of an individual segment of one leg. In the case of *Nepa* many interesting details are given concerning preliminary movements immediately prior to the termination of the feint. If *Belostoma* is mutilated by snipping off small portions of the appendages, the animal quickly comes out of the death-feint after one or two repetitions of the excision. *Nepa* acts quite differently. The legs may be cut off one at a time, and even the tip of the abdomen, without any movement on the part of the organism.

III. It was found that the duration of the feint varies considerably in different individuals. One group of *Belostomas* were put into thirty-eight death-feints; after this they refused to respond. After having been placed in water for a few moments, they again displayed the reaction. This was repeated again and again until the insects no longer feigned death. "The average time that all of the *Belostomas* feigned throughout all the series of successive death feints was eight hours." In other experiments, it was found that the responses, in both *Belostoma* and *Nepa*, became weaker toward the end of the series; also that the duration of the death-feint decreased in a succession of trials; and that the cause of the cessation of the response, in each series of experiments, while partly due to fatigue, was more largely the result of the dryness of the body while exposed to the air.

IV. Dryness tends to decrease and dampness to increase the length of the death-feint. If *Belostoma* is placed upon the surface-film, or below the water surface, the duration of the feint is diminished. When *Belostoma* is thrown into the water, it usually comes out of the death-feint immediately. Sometimes, however, the creature will bob up to the surface of the water and feign in that position.

V. The duration of the death-feint diminishes in both species when exposed to high temperatures. At a low temperature the response is lessened in *Belostoma*. In *Nepa*, on

the other hand, a low temperature prolongs the death-feint. These facts were ascertained while the insects were exposed to the atmosphere. Experiments were also undertaken with the view to discover what the result would be on the death-feigning reaction when the animals were transferred from water to the atmosphere. It was found that the duration of the feint is lessened when the transition was from water at a low temperature to the atmosphere with a temperature lower than 12° C. In both *Belostoma* and *Nepa* the death-feint considerably decreases at a low temperature.

VI. If *Belostomas* are exposed to sunlight the length of the death-feigning reaction diminishes. In certain experiments with artificial light it was discovered that both *Belostoma* and *Nepa* are aroused more quickly when subjected to a bright light than was the case with a weak light. A moving light arouses both species sooner than a stationary one. The death-feint in *Nepa* is much diminished when the creature is exposed to a bright light, if the organisms had previously been kept in the dark.

VII. The authors call attention to the work of Robertson on spiders, *Epeira producta*? and *Amaurobius* sp.? This author found that the "sham-death" reflex may be induced in the above active species "by the thoracic ganglia alone, or even by the ganglia of the posterior or two anterior segments of the thorax alone. . . . With the supra- and sub-oesophageal ganglia removed the reaction is still carried out in the active species, but it is now weaker, has a longer latent period (in *Epeira* sp. at least, and probably in *Amaurobius* sp.) and it is a rhythmically interrupted tetanus." In this same connection the work of Holmes on *Ranatra* is quoted. If the head of *Belostoma* is removed with a pair of sharp scissors, the creature generally continues to feign death. Decapitated specimens will often swim freely in the water after arousing from the feint. On removing the supra-oesophageal ganglion most of the organisms continued the death-feint; but the usual tension of the body and

appendages was very much weakened. "With those decapitated *Belostomas* that assumed the death-feigning attitude, a weakened tetanic condition of the muscles could be induced by gently stroking the abdomen with a camel's hair brush, but the instant the stroking ended the legs would sprawl apart and become lax." Certain experiments were performed by the authors in which the *Belostomas* and *Nepas* were cut into two distinct parts, the cut being made between the prothorax and the mesothorax. The operation was performed in such a manner that "neither the fused infra-oesophageal and first thoracic ganglia, nor the large ganglion, which innervates the posterior pairs of legs and the abdomen, are injured." In such cases, in *Belostoma*, the two parts continued to feign death. In fact the response continued for a considerable length of time after the operation. The posterior portion, after coming out of the death-feint, if thrown into water, would attempt to swim by making a few feeble movements with the appendages. When the water bug, *Belostoma*, is severed between the first two thoracic segments, the two portions will continue the feigning posture; yet when the head is removed, the organism immediately arouses from the death-feint. In other cases the insect (*Nepa*) was severed across the metathorax, posterior to the last ganglion, and it was found that the posterior portion did not respond to stimuli at all even when the ventral surface of the abdomen was touched with a red hot needle; but the part in front of the cut reacted much in the same manner as an uninjured specimen.

VIII. In the discussion of "The Origin and Development of the Death-Feint," the authors review the ideas of Preyer, Romanes and Holmes. They call attention to the fact that both *Belostoma* and *Nepa* tend to cling together and form clusters, a positively thigmotactic response. It is also a noticeable phenomenon that contact stimuli play a large rôle in the lives of both of these organisms. "The various members of the families Belostomidae and Nepidae" are largely responsive to touch stimuli. The authors believe that the

phenomenon of death-feigning may have its origin "out of positively thigmotactic propensities."

IX. The authors do not believe that in the lower animals there is any conscious effort to deceive their enemies through the death-feigning response. They consider that the act is an instinctive one. There is no room for the supposition that the response is anything more than a non-intelligent one. "The death-feint in the arthropods is simply a non-intelligent instinctive act."

C. F. CURTIS RILEY

URBANA, ILL.,

November 14, 1911

The Sun. By CHARLES G. ABBOT. D. Appleton & Co. 1911. Pp. xxv + 448, illustrated.

Upon the steady and regular maintenance of the amount of heat received by the earth from the sun depends the very existence of life upon our planet. Any large variation in the amount of solar heat would totally destroy the world as it is to-day, would make it an uninhabitable furnace or a frozen waste of icebergs. This dependence upon the life-giving properties of the sun has been dimly realized from the earliest times; in many lands and in many ages the sun has been worshipped as the all-powerful, the god of gods. Yet it is only within comparatively recent years that anything has been known as to what the sun really is, and whence is derived its constant outpourings of light- and life-giving energy. A hundred years ago, so little was known about heat and its properties that the elder Herschel could advance his fanciful and utterly impossible theory of a habitable sun.

To within the last three or four years widely divergent views have been held as to how much heat (radiant energy) reaches the earth from the sun in a given time. The younger Herschel in 1838 made the first scientific estimate of the quantity of heat derived from the sun. He found that a beam of sunlight three inches in diameter would raise the temperature of half a pint of water 0.37 of a degree per minute, or, were the sun in the zenith, the amount of heat received would

melt a coating of ice one inch in thickness in two hours and a quarter. Langley, about 1880 devised the "bolometer," an electrical thermometer so delicate that differences of temperature of less than one hundred-millionth of a degree can be detected. This instrument, as perfected and used by Langley and Abbot, has revolutionized the methods of studying the character and amount of heat received from the sun. The latest researches of Abbot and the Smithsonian Institution show that if the sun's rays could be completely employed to melt ice they would suffice to melt a coating one inch thick in one hour and thirty-eight minutes, or a layer 426 feet thick in a year.

Abbot's book is a study of the latest researches on the light and heat of the sun, of the sources from which that body derives its apparently inexhaustible supply of energy, and of the methods and instruments by means of which the great advances in knowledge have been made. It is a book by an active and successful worker in the field of solar investigation, a particularly sane and successful worker. The simple astronomical facts regarding the size, shape and distance of the sun, the phenomena of the visible surface, the rotation and the spots, are reviewed at length, but the feature of the book is the exhaustive treatment of all questions connected with the sun's action as a fountain of light and heat.

As to what the sun really is, Abbot is a strong advocate of the theory of a purely gaseous body (except sun spots). That the sun is mainly gaseous has been the accepted theory, but most writers and investigators have considered the visible surface as semi-fluid, as a sort of cloudlike formation floating in the outer gaseous envelopes. Sunspots are regarded by Abbot as cyclonic storms, or vortices, similar in form to water spouts seen at sea, the whirl carrying gases from below upward. The rapid uprush of the gases and the spreading out into the trumpet shape top, cause a rapid expansion and great cooling. This cooling carries the temperature down, and allows the formation of liquids, and thus the spots may be cloudlike forms, with some

liquid and even solid particles. The peculiar periodicity of the spots in number and size is as yet unexplained. As to the source of the sun's heat and energy, Abbot shows that we may still regard Helmholtz's contractive hypothesis as adequate to satisfy the requirements of geology and physics. He is not carried off his feet by the popular scientific craze of explaining everything as a phase of radio-activity. Radio-active processes may have contributed somewhat to the store of solar energy, but that they have been any appreciable factor has not yet been shown.

The book is well written and is full of interesting matter for the scientist and for the general student. In it are tabulated and brought together the results of many researches, some hitherto unpublished, and others only to be found in special journals; the various hypotheses of solar physics are clearly set forth, and the merits and defects of each explained. It is the best work on the subject that has appeared for many years and will rank with and take the place of the similar book, by the late Charles A. Young, which for so many years was regarded as the standard treatise on "The Sun."

CHARLES LANE POOR

COLUMBIA UNIVERSITY

SCIENTIFIC JOURNALS AND ARTICLES

THE March issue of *Terrestrial Magnetism and Atmospheric Electricity* contains the following articles:

"Ueber den elektrischen Strom Erde-Luft und seinen Zusammenhang mit den Erdströmen und den Schwankungen des erdmagnetischen Feldes," A. Gockel.

"Results of Magnetic Observations made by the United States Coast and Geodetic Survey at the Time of the Solar Eclipse of April 28, 1911," O. H. Tittmann.

"Magnetic Declinations and Chart Corrections in the Indian Ocean Continued," L. A. Bauer and W. J. Peters.

"Die Verteilung der Leitfähigkeit der Atmosphäre über dem grossen Ocean nach den Beobachtungen der *Galilee*," A. Nippoldt.

"Determination of the Pole Distance of a very Small Magnet" (abstract), J. M. Miller.

SPECIAL ARTICLES

DECIDUOUS ROOTLETS OF DESERT PLANTS

A STUDY of the roots of many perennials and of a few annuals growing under arid conditions in the Tucson region, shows that there are two sorts of rootlets which, to a degree, have similar functions, but which usually have an unlike fate. Whether analogous plants of the more moist regions have similar rootlets is unknown to the writer. A characterization of the rootlets in question can be made by describing those of a typical shrub, such as *Franseria deltoidea*, and by referring to analogous rootlets of some of the annuals.

In *Franseria* the tips of the main roots end in a brush of slender rootlets which bear root hairs. Most of these terminal rootlets are formed during the moist seasons, generally summer, and die during the following dry season, but some survive to extend the root-system. Such rootlets are found on the most deeply penetrating, as well as the most shallowly placed roots. But on the more superficial roots only there is, in addition, another type of rootlet. These are filamentous, 2 cm., more or less, in length, in groups of about one half dozen, which occur from 2 to 4 cm. apart. They arise from older roots only, and hence are adventitious. Since these rootlets are formed during the moister seasons each year, and die during the succeeding dry season, and never, or almost never, persist to form permanent roots, I have referred to them as deciduous.¹

The deciduous rootlets, as before suggested, are found on roots which are placed near the surface of the soil. From this fact, and from the known variation in water content of the superficial soil horizon, it is assumed that the deciduous rootlets are perhaps the first absorbing organs, after the beginning of the rainy season, to function. Also owing to the fact that the superficial soil layers are the first to become desiccated, it is assumed that the deciduous rootlets cease activities before the

other type referred to. It is probable, therefore, that the deciduous rootlets are of great importance in providing water absorption surface during the time of maximum, or optimum, water supply, and that the second type of rootlets in deeper soil, lingering longer, serve to provide the plant with water during a longer period, probably until the next season of precipitation.

Undoubtedly an important factor in the physiology of water absorption, and in the water relation, generally speaking, is that of the distance of water transport. Where the distance from the point of absorption to the place of evaporation is great it is probable that a given amount of water is less efficient in a longer than in a shorter transport. We have, in the formation of the deciduous rootlets, the interesting condition that the water absorption surface is enormously increased without at the same time increasing the distance of water transport. The importance of this in the physiology of the plant will appear at a glance.

Nearly all perennials which have been examined are provided with deciduous rootlets. It is not supposed, however, that these rootlets are essentially different from the other type, although they have a different origin, and although they appear to have a somewhat different function. From a few instances it has been seen that permanent roots may be derived from groups of rootlets which probably were indistinguishable from the deciduous rootlets, but which were so fortunately placed that survival was possible.

An analogous condition, but naturally differing in many ways, is to be found in the root-systems of several desert annuals. In such forms, in addition to the usual and, of course, ephemeral absorbing roots, there are at the base of many laterals rudimentary rootlets. These may remain rudimentary, never developing, or if the moisture conditions favor, they may develop. Where such rootlets are not found, it seems from certain experiments that they can not easily be induced. Probably the greatest advantage to an annual bearing rudimental rootlet is that

¹"The Root Habits of Desert Plants," W. A. Cannon, Carnegie Institution of Washington, Publication No. 131, 1911.

should there be a return of rains, following a rainy season, so soon after the rainy season that the annuals are still living, the rudimentary roots quickly develop, enabling the plant to complete its growth, or to renew it. The matter of distance of water transport in the annuals would hardly come into the problem.

W. A. CANNON

DESERT LABORATORY

THE EFFECT OF NARCOTICS UPON THE DEVELOPMENT OF THE HEN'S EGG

ONE of the evident difficulties experienced in experimentation with the eggs of birds is that due to their large size, which makes it impossible to use the large numbers of eggs that may be handled in the case of fishes or amphibians. Also, while it is usually possible to obtain eggs at any season of the year, if one be willing to pay the price, the percentage of infertile eggs is usually so high except during the spring that the time for profitable experimentation is quite limited.

The experiments here described are of a purely preliminary nature. It is the purpose of the writer to continue the experiments until the number of eggs used will justify some general conclusions.

The reagents used were alcohol, ether, chloroform, chlorotone and magnesium chloride. One or two of these proved so almost universally fatal in their effects that they will probably not be employed in further experimentation.

Alcohol.—This reagent was employed as follows: the eggs were placed in the incubator and left for a number of hours (five to seventeen, in different experiments); they were then placed in a glass specimen jar having a glass cover, with raw cotton wet with from 1 to 5 c.c. of 95 per cent. alcohol; the jar was covered and replaced in the incubator, where it was left for from three to twelve hours, after which the eggs were removed from the atmosphere of alcohol, thoroughly aired and replaced in the incubator (which had also been aired) for about forty-eight hours before being opened. The glass jar was of about 1,200 c.c. capacity, and not more than eight

eggs were placed in it at once, so that there was a considerable volume of air for each egg. When the lid was removed, to take the eggs from the jar, there was always a strong smell of alcohol.

Of the eggs treated in this way only about 25 per cent. contained living embryos when opened. About half of the embryos obtained from these eggs were abnormal to a greater or less extent. The character of the abnormalities will be described when further experiments have furnished more material.

Ether.—The experiments with ether were conducted in the same general manner as those with alcohol, except that, as a rule, only 1 or 2 c.c. of ether were used.

The effect of ether seemed to be much less severe than that of alcohol, only about 35 per cent. of the embryos being killed. Of the embryos removed from the eggs, less than half were abnormal.

Chloroform.—Chloroform was employed in the same manner as was ether, and, while fewer experiments were tried, not a single egg, opened after being submitted to this reagent, contained a living embryo, showing that it is much more toxic in effect, under these conditions, than either alcohol or ether.

Chlorotone.—This reagent was employed as a .1 per cent. solution in distilled water. In one experiment the eggs were kept in the incubator for ten hours before introducing the chlorotone; in the other experiments the chlorotone was introduced into the fresh egg. The method employed was to carefully remove about a square centimeter of shell from the side of the egg, and, with a clean glass tube, blow out about 5 to 10 c.c. of the albumen, without touching the yolk; the space thus made was filled with the reagent; the opening was then sealed with a piece of fresh shell, with strips of shell membrane stuck around the edge with some of the albumen that had been blown out of the egg. This is the method of closing an incubating egg used by Miss Peebles.

This treatment proved fatal to more than 90 per cent. of the embryos, but a few control experiments, where the eggs were opened and

sealed again without introducing any foreign substance, gave such a large percentage of fatalities that too large a percentage of fatalities in the experiments proper should not be attributed to the reagent.

Magnesium Chloride.—The magnesium chloride was employed as a 10 per cent., 16 per cent. and 33 per cent. dilution of the molecular solution of the salt in normal salt solution; that is to say, ten parts of the molecular solution of magnesium chloride were diluted with ninety parts of normal salt solution; etc.

The reagent was introduced into the eggs in the same manner as was the chlorotone; in some cases into fresh eggs, in other cases into the eggs after they had been in the incubator from ten to twenty hours.

The effect of these weak magnesium chloride solutions was about the same as the chlorotone, the embryos being killed in practically every case, or, at least, the process of incubation was inhibited. As in the case of chlorotone the results were here largely vitiated by faulty technic in opening and closing the eggs for the introduction of the reagent.

These preliminary experiments, as has been said, while too limited in number to give definite results, will serve as a guide for further work, especially in regard to the character and strength of reagents and the length of time they should be allowed to act.

ALBERT M. REESE

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INHIBITION OF CELL DIVISION IN PARAMÆCIUM

IN connection with the discussion of "potential immortality" in Protozoa (in other words, their ability to continue their physical existence indefinitely, barring accident and disease, through the bodily "splitting up" of each individual into its two offspring, each repeating the process, which is continued "*ad infinitum*"), it may be of some interest to note the length of time an individual has been observed to maintain its identity—in other words, to continue living, without dividing into its progeny. The writer has suc-

ceeded in preventing one specimen of *Paramæcium caudatum* from dividing, for the space of a little over thirty-two days, by keeping it confined in capillary tubes of bores too small to permit it to turn back readily.

Control specimens had meanwhile divided on an average of once a day. In other words, if the confined specimen had been allowed to divide unmolested, it would have divided into four billion, two hundred and ninety-four million, nine hundred and sixty-seven thousand, two hundred and ninety-six offspring!

The irritation caused by the confining walls is doubtless a factor of as great importance as the accumulation of the products of excretion, and the lack of nutrition; since specimens which were daily taken from their tubes and allowed to swim about in a fresh infusion containing an abundance of *Bacterium termo*, for a number of hours before being transferred to new tubes, nevertheless refused to divide.

Particles which appear to be cast-off portions of the specimen's body, were frequently observed in the tubes with individuals thus treated, thus suggesting that increase of protoplasmic bulk may take place without the customary sequence of cell division, even in well-nourished individuals.

Conklin's observations on *Crepidula* seem to indicate that the dwarfing of those forms in small hermit crab shells (dwarf forms being always found in small hermit shells, and "giant" forms in large hermit shells) is due to an inhibition of cell division, since the difference in size is due to the difference in the number of cells, rather than to differences in cell size. Crustacea, Echinodermata, Mollusca, Amphibia, etc., reared in small vessels are always dwarfed, and this too must be due to an inhibition of cell division.

In the case of *Crepidula*, the fact that the hermit shells are open to the ocean would indicate that the accumulation of waste products, and lack of proper nutrition can hardly be regarded as a sole, or even the chief, cause of this inhibition of cell division, and the writer is inclined to the opinion that narrower confinement in some way acts as an important factor in the process.

If a dwarf *Crepidula* be removed from a small hermit shell, and find lodgment elsewhere, it is readily seen that the inhibitory influence was merely temporary, since the dwarf then grows to the normal size. So too the confined *Paramacium*, after being liberated, soon begins the process of fission at the normal rate.

A more detailed account of these experiments, together with some observations on the behavior of Protozoa confined in capillary tubes, will shortly appear in another publication.

G. C. CRAMPTON

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, MASS.

SOCIETIES AND ACADEMIES

THE MICHIGAN ACADEMY OF SCIENCE
SECTION OF ZOOLOGY

THE zoological section of the Michigan Academy of Science met at the University of Michigan, March 28. Mr. Peter Okkleberg was chosen president for the coming year. The following program of papers was presented:

"Results of the Mershon Expedition to the Charity Islands, Lake Huron, Amphibians and Reptiles," Crystal Thompson and Helen Thompson, Ann Arbor.

"Some Bird and Mammal Records for Michigan," N. A. Wood, Ann Arbor.

"Directions for Collecting and Preserving Specimens of Reptiles and Amphibians for Museum Purposes," Alexander G. Ruthven, Ann Arbor.

"The Breeding Birds of the Charity Islands, Lake Huron, with Additional Notes on the Migrants," N. A. Wood.

"On the Wisconsin Wood-frog," Helen Thompson.

"The Pickerel Frog, *Rana palustris* LeConte, in Michigan," Crystal Thompson.

"External Conditions and the Growth Period in the Eggs of *Hydatina senta*," A. F. Shull, Ann Arbor.

"The Influence of Egg and Sperm in Inheritance of Egg Characters in *Hydatina senta*," A. F. Shull.

"The Origin of Continental Forms, 3. A Preliminary Note on Faunal and Floral Relations," Howard B. Baker, Detroit.

"A Collection of Mammals from Oseola

County, Michigan," Orrin J. Wenzel, Ann Arbor.

"The Mouth Reflex of Physa: May it be Substituted for the Salivary Reflex of Pawlow in Studies of the Nervous System of Snails?" Elizabeth Thompson, Ann Arbor.

"Pseudohermaphroditism in the Brook Lamprey," Peter Okkleberg, Ann Arbor.

"Factors that Determine the Location of the Borings of the Yellow-bellied Sapsucker in the Yellow Birch," Margaret W. Taggart. (Presented by Jacob Reighard.)

"Report on the Zoological Work done at the Biological Station of the U. of M. at Douglas Lake," Jacob Reighard, Ann Arbor.

"Cestode Parasites of Fresh-water Fish," George R. La Rue, Ann Arbor.

"New Methods of making *in toto* Preparations," George R. La Rue.

"The Distribution of the Ancyliidae," Bryant Walker, Detroit.

"Preliminary Report on the Ecology of the Mollusks of the Douglas Lake Region," H. Burlington Baker, Ann Arbor.

"The Origin of the Germ Cells in the Toad Fish," Emory Sink, Ann Arbor.

"The Application of Calorimetric Methods to the Study of Embryology," O. C. Glaser, Ann Arbor.

"Notes on the Amphibia and Mammals of Gratiot County, Michigan," H. M. MacCurdy, Alma.

"Check-list of Michigan Lepidoptera. I. Rhopalocera (Butterflies)," W. W. Newcombe, Detroit.

"Some Observations on the Muskrat Houses near Ann Arbor," F. C. Gates, Ann Arbor.

"On some Amphibians and Reptiles from the State of Vera Cruz, Mexico," Alexander G. Ruthven.

GEORGE R. LA RUE

UNIVERSITY OF MICHIGAN

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

THE tenth regular meeting of the society was held at Dr. Stiles' residence on March 14, 1912, Dr. Stiles acting as host and Mr. Crawley as chairman. The receipt of a set of author reprints from Dr. Arthur Shipley for the society's library was noted.

Dr. Stiles reported that the Index-Catalogue of Medical and Veterinary Zoology dealing with the subjects Cestoda and Cestode Diseases, by Stiles and Hassall, was now in manuscript ready for

press. He also reported that he had in preparation a list of the names of all hookworms.

The secretary read the following communication from Dr. Fritz Zschokke:

Gordius aquaticus L. as a Parasite of Man.

A two and one half year old boy at Dorentingen, a village near Solluthorn (Switzerland), passed per anum a male *Gordius aquaticus* L. about 17 centimeters long, together with several specimens of *Oxyuris*. After passage, the worm lived three days free in water. According to the attending physician, the patient was subject to nervous troubles, which disappeared immediately upon the removal of the parasite. Symptoms involving the intestinal canal were present only to a slight extent.

Up to 1906, 9 authentic cases of the occurrence of *Gordius* in man were known. These occurred in Italy (3), France (3), North America (1), Bavaria (1) and Austria (1). To these must now be added the case reported from Switzerland. Most of the carriers of the parasites are boys and young people from two and a half to twenty-two years old. Systematically, the *gordius* forms found in human beings belong to the species: *Gordius aquaticus* L., *G. villoti* Rosa, *Paragordius varius* Leidy, *P. tricuspidatus* L., *Parachordodes tolosanus* Duj., *P. pustulosus* Baird and *P. violaceus* Baird.

The duration of the pseudoparasitic infection of the human intestinal canal by *Gordius* may extend over months; it is accompanied by the symptoms of a more or less clearly indicated helminthiasis which disappear with the discharge of the parasite by mouth or anus of the host individually.

Probably the infection takes place through the ingestion in drinking water of the free-living worms which have already passed through their parasitic developmental stage in insect larvæ and predaceous insects. Also, the patient at Dorentingen had the habit of drinking from a watering trough.

Gordius in the adult state is well fitted for a parasitic mode of living. Its strong chitinous covering protects the worm against the digestive fluids of the host. It is in a high degree insensitive to considerable variation of temperature, and also, as G. V. Bunge has shown, to the absence of oxygen.

Dr. Ransom presented the following note:
Cysticerci in American Sheep, Reindeer and Cattle.

Federal meat inspectors are frequently finding

sheep infested with cysticerci in the heart and voluntary muscles. These cysticerci closely resemble *Cysticercus cellulosæ*, which is said to occur occasionally in sheep, and they have been provisionally identified as such. The question as to their identity is now under further investigation, since it seems unlikely that so many cases of infestation would occur in sheep, especially in view of the fact that *Cysticercus cellulosæ* is comparatively rare in this country in hogs, the usual host.

Specimens of muscle cysticerci from Alaskan reindeer have recently been received by the Bureau of Animal Industry from Dr. D. S. Neuman, of Nome, Alaska, who reports that they are very common. These cysticerci have been provisionally identified as the cysticerci of *Tænia krabbei*, a tapeworm of the dog, although in some respects they do not correspond to the available descriptions of the cysticercus of that tapeworm.

There have also been some unusually high percentages of infestation of cattle with *Cysticercus bovis*. Three lots of cattle of 251, 70 and 201 head, originating in the same locality, had 25, 41 and 39 head, respectively, infested with this parasite.

Dr. Garrison reported that in an examination of a slide of some old human feces he had found an egg of *Fasciola*, apparently *F. hepatica*, together with a number of other parasite eggs, including a lateral-spined *Schistosomum* egg. He noted that Ashford has reported finding this egg in human feces in Porto Rico.

In comment, Dr. Stiles reported that he had an adult specimen of *Fasciola* from man in Porto Rico. The *Fasciola* from sheep in Porto Rico appears to be a quite distinct species on comparison with the European specimens, but a comparison with American specimens seems to furnish a complete series of gradations between the typical Porto Rican and the European forms. Dr. Stiles noted that cases had been reported from Porto Rico of death from asphyxiation as a result of *Fasciola* attaching in the throat following the eating of raw liver. The prompt production of vomiting will carry out the flukes and save the patient. There is a total of 26 to 28 cases of infection of man with *Fasciola*, most of the cases being discovered on postmortem.

Dr. Garrison presented a report on the terminology of parasitic diseases, and the remainder of the evening was spent in a discussion of his paper.

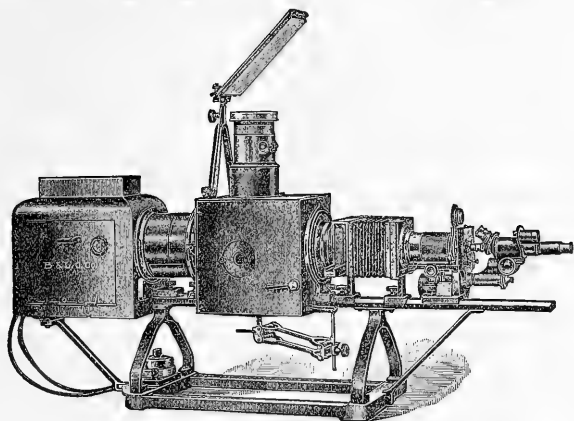
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THE HUMANIZATION OF THE TEACHING OF MATHEMATICS¹

WHEN the distinguished chairman of your mathematical conference did me the honor to request me to speak to you, he was generous enough, whether wisely or unwisely, to leave the choice of a subject to my discretion, merely stipulating that, whatever the title might be, the address itself should bear upon the professional function of those men and women who are engaged in teaching mathematics in secondary schools. Inexpertness, it has been said, is the curse of the world; and one may, not unnaturally, feel some hesitance in undertaking a task that might seem to resemble the rôle of a physician when, as sometimes happens, he is called upon to treat a patient whose health and medical competence surpass his own. I trust I am not wanting in that natural feeling. In the present instance two considerations have enabled me to overcome it. One of them is that, having had some experience in teaching mathematics in secondary schools, I might, it seemed to me, regard that experience, though it was gained more than a score of years ago, as giving something like a title to be heard in your counsels. The other consideration is that, in regard to the teaching of mathematics, whether in secondary schools or in colleges, I have acquired a certain conviction, a pretty firm conviction, which, were it properly presented, you would doubtless be generous enough and perhaps ingenious

¹ MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

¹ Address given at the meeting of the Michigan School Masters' Club, at Ann Arbor, March 28, 1912.

enough to regard as having some sort of likeness to a message.

My conviction is, that hope of improvement in mathematics teaching, whether in secondary schools or in colleges, lies mainly in the possibility of humanizing it. It is worth while to remember that our pupils are human beings. What it means to be a human being we all of us presumably know pretty well; indeed we know it so well that we are unable to tell it to one another adequately; and, just because we do so well know what it means to be a human being, we are prone to forget it as we forget, except when the wind is blowing, that we are constantly immersed in the earth's atmosphere. To humanize the teaching of mathematics means so to present the subject, so to interpret its ideas and doctrines, that they shall appeal, not merely to the computatory faculty or to the logical faculty but to all the great powers and interests of the human mind. That mathematical ideas and doctrines, whether they be more elementary or more advanced, admit of such a manifold, liberal and stimulating interpretation, and that therefore the teaching of mathematics, whether in secondary schools or in colleges, may become, in the largest and best sense, human, I have no doubt. That mathematical ideas and doctrines do but seldom receive such interpretation and that accordingly the teaching of mathematics is but seldom, in the largest and best sense, human, I believe to be equally certain. That the indicated humanization of mathematical teaching, the bringing of the matter and the spirit of mathematics to bear, not merely upon certain fragmentary faculties of the mind, but upon the whole mind, that this is a great desideration is, I assume, beyond dispute.

How can such humanization be brought about? The answer, I believe, is not far

to seek. I do not mean that the answer is easy to discover or easy to communicate. I mean that the game is near at hand and that it is not difficult to locate it, though it may not be easy to capture it. The difficulty inheres, I believe, in our conception of mathematics itself; not so much in our conception of what mathematics, in a definitional sense, is, for that sense of what mathematics is has become pretty clear in our day, but in our sense or want of sense of what mathematics, whatever it may be, humanly signifies. In order to humanize mathematical teaching it is necessary, and I believe it is sufficient, to come under the control of a right conception of the human significance of mathematics. It is sufficient, I mean to say, and it is necessary, greatly to enlarge, to enrich and to vitalize our sense of what mathematics, regarded as human enterprise, signifies.

What does mathematics, regarded as an enterprise of the human spirit, signify? What is a just and worthy sense of the human significance of mathematics?

To the extent in which any of us really succeeds in answering that question worthily, his teaching will have the human quality, in so far as his teaching is, in point of external circumstance, free to be what it would. I believe it is important to put the question, and it is with the putting of it rather than with the proposing of an answer to it that I am here at the outset mainly concerned. For any one who is really to acquire possession of an answer that is worthy must win the answer for himself. I need not say to you that such an acquisition as a worthy answer to this kind of question does not belong to the category of things that may be lent or borrowed, sold or bought, donated or acquired by gift. No doubt the answers we may severally win will differ as our temperaments differ. Yet the matter is not solely

a matter of temperament. It is much more a matter first of knowledge and then of the evaluation of the knowledge and of its subject. To the winning of a worthy sense of the human significance of mathematics two things are indispensable, knowledge and reflection: knowledge of mathematics and reflection upon it. To the winning of such a sense it is essential to have the kind of knowledge that none but serious students of mathematics can gain. Equally essential is another thing and this thing students of mathematics in our day do not, or do but seldom, gain. I mean the kind of insight and the liberality of view that are to be acquired only by prolonged contemplation of the nature of mathematics and by prolonged reflection upon its relations of contrast and similitude to the other great forms of spiritual activity.

The question, though it is a question about mathematics, is not a mathematical question, it is a philosophical question. And just because it is a philosophical question, mathematicians, despite the fact that one of the indispensable qualifications for considering it is possessed by them alone, have in general ignored it. They have, in general, ignored it, and their ignoring of it may help to explain the curious paradox that whilst the world, whose mathematical knowledge varies from little to less, has always as if instinctively held mathematical science in high esteem, it has at the same time usually regarded mathematicians as eccentric and abnormal, as constituting a class apart, as being something more or something less than human. It may explain, too, I venture to believe it does partly explain, both why it is that in the universities the number of students attracted to advanced lectures in mathematics compared with the numbers drawn to advanced courses in some other great subjects not inherently more attractive, is

so small; and why it is that, among the multitudes who pursue mathematics in the secondary schools, only a few find in the subject anything like delight. For I do not accept the traditional and still current explanation, that the phenomenon is due to a well-nigh universal lack of mathematical faculty. I maintain, on the contrary, that a vast majority of mankind possess mathematical faculty in a very considerable degree. That the average pupil's interest in mathematics is but slight, is a matter of common knowledge. His lack of interest is, in my opinion, due, not to a lack of the appropriate faculty in him, but to the circumstance that he is a human being, whilst mathematics, though it seems with human interest, is not presented to him in its human guise.

If you ask the world—represented, let us say, by the man in the street or in the market place or the field—to tell you its estimate of the human significance of mathematics, the answer of the world will be, that mathematics has given mankind a metrical and computatory art essential to the effective conduct of daily life, that mathematics admits of countless applications in engineering and the natural sciences, and finally that mathematics is a most excellent instrumentality for giving mental discipline. Such will be the answer of the world. The answer is intelligible, it is important, and it is good so far as it goes; but it is far from going far enough and it is not intelligent. That it is far from going far enough will become evident as we proceed. That the answer is not intelligent is evident at once, for the first part of it seems to imply that the rudimentary mathematics of the carpenter and the counting-house is scientific, which it is not; the second part of the answer is but an echo by the many of the voice of the few; and, as to the final part, the world's

conception of intellectual discipline is neither profound nor well informed but is itself in sorry need of discipline.

If, turning from the world to a normal mathematician, you ask him to explain to you the human significance of mathematics, he will repeat to you the answer of the world, of course with far more appreciation than the world has of what the answer means, and he will supplement the world's response by an important addition. He will add, that is, that mathematics is the exact science, the science of exact thought or of rigorous thinking. By this he will not mean what the world would mean if the world employed, as sometimes it does employ, the same form of words. He will mean something very different. Especially if he be, as I suppose him to be, a normal mathematician of the modern critical type, he will mean that mathematics is, in the oft-cited language of Benjamin Peirce, "the science that draws necessary conclusions;" he will mean that, in the felicitous words of William Benjamin Smith, "mathematics is the universal art apodictic;" he will mean that mathematics is, in the nicely technical phrase of Pieri, "a hypothetico-deductive system." If you ask him whether mathematics is the science of rigorous thinking about *all* the things that engage the thought of mankind or only about a few of them, such as numbers, figures, certain operations, and the like, the answer he will give you depends. If he be a normal mathematician of the elder school, he will say that mathematics is the science of rigorous thinking about only a relatively few things and that these are such as you have exemplified. And if now, with a little Socratic persistence, you press him to indicate the human significance of a science of rigorous thinking about only a few of the countless things that engage human thought, his answer will give you

but little beyond a repetition of the above-mentioned answer of the world. But if he be a normal mathematician of the modern critical type, he will say that mathematics is the science of rigorous thinking about all the things that engage human thought, about *all* of them, he will mean, in the sense that thinking, as it approaches perfection, tends to assume certain definite forms, that these forms are the same whatever the subject matter of the thinking may be, and that mathematics is the science of these forms *as forms*. If you respond, as you well may respond, that, in accordance with this ontological conception of mathematics, this science, instead of thinking about *all*, thinks about *none*, of the concrete things of interest to human thought, and that accordingly Mr. Bertrand Russell was right in saying that "mathematics is the science in which one never knows what one is talking about nor whether what one says is true"—if you respond that, from the point of view above assumed, that delicious *mot* of Mr. Russell's must be solemnly held as true, and then if, in accordance with your original purpose, you once more press for an estimation of the human significance of such a science, I fear that the reply, if your interlocutor is a mathematician of the normal type, will contain little that is new beyond the assertion that the science in question is very interesting, where, by interesting, he means, of course, interesting to mathematicians. It is true that Professor Klein has said: "Apart from the fact that pure mathematics can not be supplanted by anything else as a means for developing the purely logical faculties of the mind, there must be considered here as elsewhere the necessity of the presence of a few individuals in each country developed in a far higher degree than the rest, for the purpose of keeping up and gradually raising the *general*

standard. Even a slight raising of the general level can be accomplished only when some few minds have progressed far ahead of the average." Here indeed we have, in these words of Professor Klein, a hint, if only a hint, of something better. But Professor Klein is not a mathematician of the normal type, he is hypernormal. If, in order to indicate the human significance of mathematics regarded as the science of the forms of thought as forms, your normal mathematician were to say that these forms constitute, of themselves, an infinite and everlasting world whose beauty, though it is austere and cold, is pure, and in which is the secret and citadel of whatever order and harmony our concrete universe contains, it would yet be your right and your duty to ask, as the brilliant author of "East London Visions" once asked me, namely, what is the human significance of "this majestic intellectual cosmos of yours, towering up like a million-lustered iceberg into the arctic night," seeing that, among mankind, none is permitted to behold its more resplendent wonders save the mathematician himself? But the normal mathematician will not say what I have just now supposed him to say; he will not say it, because he is, by hypothesis, a normal mathematician, and because, being a normal mathematician, he is exclusively engaged in exploring the iceberg. A farmer was once asked why he raised so many hogs. "In order," he said, "to buy more land." Asked why he desired more land, his answer was, "in order to raise more corn." Being asked to say why he would raise more corn, he replied that he wished to raise more hogs. If you ask the normal mathematician why he explores the iceberg so much, his answer will be, in effect at least, "in order to explore it more." In this exquisite circularity of motive, the farmer and the normal mathema-

tician are well within their rights. They are within their rights just as a musician would be within his rights if he chanced to be so exclusively interested in the work of composition as never to be concerned with having his creations rendered before the public and never to attempt a philosophic estimate of the human worth of music. The distinction involved is not the distinction between human and inhuman, between social and anti-social; it is the distinction between what is human or inhuman, social or anti-social, and what is neither the one nor the other. No one, I believe, may contest the normal mathematician's right as a mathematical student or investigator to be quite indifferent as to the social value or the human worth of his activity. Such activity is to be prized just as we prize any other natural agency or force that, however undesignedly, yet contributes, sooner or later, directly or indirectly, to the weal of mankind. The fact is that, among motives in research, scientific curiosity, which is neither moral nor immoral, is far more common and far more potent than charity or philanthropy or benevolence. But when the mathematician passes from the rôle of student or investigator to the rôle of teacher, that right of indifference ceases, for he has passed to an office whose functions are social and whose obligations are human. It is not his privilege to chill and depress with the encasing fogs of the iceberg. It is his privilege and his duty, in so far as he may, to disclose its "million-lustered" splendors in all their power to quicken and illuminate, to charm and edify, the whole mind.

The conception of mathematics as the science of the forms of thought as forms, the conception of it as the refinement, prolongation and elaboration of pure logic, is, as you are doubtless aware, one of the great outcomes, perhaps I should say it is

the culminating philosophical outcome, of a century's effort to ascertain what mathematics, in its intimate structure, is. This conception of what mathematics is comes to its fullest expression and best defense, as you doubtless know, in such works as Schroeder's "Algebra der Logik," Whitehead's "Universal Algebra," Russell's "Principles of Mathematics," Peano's "Formulario Mathematico," and especially in Whitehead and Russell's monumental "Principia Mathematica." I cite this literature because it tells us what, in a definitional sense, the science in which the normal mathematician is exclusively engaged, is. If we wish to be told what that science humanly signifies, we must look elsewhere; we must look to a mathematician like Plato, for example, or to a philosopher like Poincaré, but especially must we look to our own faculty for discerning those fine connective things—community of aim, interformal analogies, structural similitudes—that bind all the great forms of human activity and aspiration—natural science, theology, philosophy, jurisprudence, religion, art and mathematics—into one grand enterprise of the human spirit.

In the autumn of 1906 there was published in *Poet Lore* a short poem which, though it says nothing explicitly of mathematics, yet admits of an interpretation throwing much light upon the human significance of the science and indicating well, I think, the normal mathematician's place in the world of spiritual interests. The author of the poem is my excellent friend and teacher, Professor William Benjamin Smith, mathematician, philosopher, poet and theologian. I have not asked his permission to interpret the poem as I shall invite you to interpret it. What its original motive was I am not informed—it may have been the exceeding beauty of the ideas expressed in it or the harmonious

mingling of their light with the melody of their song. The title of the poem is "The Merman and the Seraph." As you listen to the reading of it, I shall ask you to regard the merman as representing the normal mathematician and the seraph as representing, let us say, the life of the emotions in their higher reaches and their finer susceptibilities.

I

Deep the sunless seas amid,
Far from Man, from Angel hid,
Where the soundless tides are rolled
Over Ocean's treasure-hold,
With dragon eye and heart of stone,
The ancient Merman mused alone.

II

And aye his arrowed Thought he wings
Straight at the inmost core of things—
As mirrored in his Magic glass
The lightning-footed Ages pass,—
And knows nor joy nor Earth's distress,
But broods on Everlastingness.
"Thoughts that love not, thoughts that hate not,
Thoughts that Age and Change await not,
All unfeeling,
All revealing,
Scorning height's and depth's concealing,
These be mine—and these alone!"—
Saith the Merman's heart of stone.

III

Flashed a radiance far and nigh
As from the vertex of the sky,—
Lo! a Maiden beauty-bright
And mantled with mysterious might
Of every power, below, above,
That weaves resistless spell of Love.

IV

Through the weltering waters cold
Shot the sheen of silken gold;
Quick the frozen Heart below
Kindled in the amber glow;
Trembling Heavenward Nekkan yearned
Rose to where the Glory burned.
"Deeper, bluer than the skies are,
Dreaming meres of morn thine eyes are
All that brightens
Smile or heightens
Charm is thine, all life enlightens,

Thou art all the soul's desire.'—
 Sang the Merman's Heart of Fire.
 "Woe thee, Nekkan! Ne'er was given
 Thee to walk the ways of Heaven;
 Vain the vision,
 Fate's derision,
 Thee that raps to realms elysian,
 Fathomless profounds are thine'—
 Quired the answering voice divine.

V

Came an echo from the West,
 Pierced the deep celestial breast;
 Summoned, far the Seraph fled,
 Trailing splendors overhead;
 Broad beneath her flying feet,
 Laughed the silvered ocean-street.

VI

On the Merman's mortal sight
 Instant fell the pall of Night;
 Sunk to the sea's profoundest floor
 He dreams the vanished Vision o'er,
 Hears anew the starry chime,
 Ponders aye Eternal Time.
 "Thoughts that hope not, thoughts that fear not,
 Thoughts that Man and Demon veer not
 Times unending
 Comprehending,
 Space and worlds of worlds transcending,
 These are mine—but these alone!"—
 Sighs the Merman's heart of stone.

I have said that the poem, if it receive the interpretation that I have invited you to give it, throws much light on the human significance of mathematics and indicates well the place of the normal mathematician in the world of spiritual interests. No doubt the place of the merman and the place of the angel are not the same: no doubt the world of whatsoever in thought is passionless, infinite and everlasting, and the world of whatsoever in feeling is high and beauteous and good are distinct worlds, and they are sundered wide in the poem. But, though in the poem they are held widely apart, in the poet they are united. For the song is not the merman's song nor are its words the words of the

seraph. It is the voice of the poet—a voice of man. The merman's world and the world of the seraph are not the same, they are very distinct; in conception they are sundered; they may be sundered in life, but in life it need not be so. The merman indeed is confined to the one world and the seraph to the other, but man, a man unless he be a merman, may inhabit them both. For the angel's denial, the derision of fate, is not spoken of man, it is spoken of the merman; and the merman's sigh is not his own, it is a human sigh—so lonely seems the merman in the depths of his abode.

No, the world of interests of the human spirit is not the merman's world alone nor the seraph's alone. It is not so simple. It is rather a cluster of worlds, of worlds that differ among themselves as differ the lights by which they are characterized. As differ the lights. The human spirit is susceptible of a variety of lights and it lives at once in a corresponding variety of worlds. There is perception's light, commonly identified with solar radiance or with the radiance of sound, for music, too, is, to the spirit, a kind of illumination: perceptual light, in which we behold the colors, forms and harmonies of external nature: a beautiful revelation—a world in which any one might be willing to spend the remainder of his days if he were but permitted to live so long. And there is imagination's light, disclosing a new world filled with wondrous things, things that may or may not resemble the things revealed in perception's light but are never identical with them: light that is not superficial nor constrained to paths that are straight but reveals the interiors of what it illuminates and phases that look away. Again, there is the light of thought, of reason, of logic, the light of analysis, far dimmer than perception's light, dimmer, too, than that of imagination, but far more penetrating and far more

ubiquitous than either of them, disclosing things that curiously match the things that they disclose and countless things besides, namely, the world of ideas and the relations that bind them: a cosmic world, in the center whereof is the home of the merman. There remains to be named a fourth kind of light. I mean the light of emotion, the radiance and glory of things that, save by gleams and intimations, are not revealed in perception or in imagination or in thought: the light of the seraph's world, the world of the good, the true and the beautiful, of the spirit of art, of aspiration and of religion.

Such, in brief, is the cluster of worlds wherein dwell the spiritual interests of the human beings to whom it is our mission to teach mathematics. My thesis is that it is our privilege to show, in the way of our teaching it, that its human significance is not confined to one of the worlds but, like a subtle and ubiquitous ether, penetrates them all. Objectively viewed, conceptually taken, these worlds, unlike the spheres of the geometrician, do not intersect—a thing in one of them is not in another; but the things in one of them and the things in another may own a fine resemblance serving for mutual recall and illustration, effecting transfer of attention—transformation as the mathematicians call it—from world to world; for whilst these worlds of interest, objectively viewed, have naught in common, yet subjectively they are united, united as differing mansions of the house of the human spirit. A relation, for example, between three independent variables exists only in the gray light of thought, only in the world of the merman; the habitation of the geometric locus of the relation is the world of imagination; if a model of the locus be made or a drawing of it, this will be a thing in the world of perception; finally, the wondrous correlation

of the three things, or the spiritual qualities of them—the sensuous beauty of the model or the drawing, the unfailing validity of the given relation holding as it does throughout “the cycle of the eternal year,” the immobile presence of the locus or image poised there in eternal calm like a figure of justice—these may serve, in contemplating them, to evoke the radiance of the seraph's world: and thus the circuit and interplay, ranging through the world of imagination and the world of thought from what is sensuous to what is supernal, is complete. It would not have seemed to Plato, as it may seem to us, a far cry from the prayer of a poet to the theorem of Pythagoras, for example, or to that of Archimedes respecting a sphere and its circumscribing cylinder. Yet I venture to say, that calm reflection upon the existence and nature of such a theorem—cloistral contemplation, I mean, of the fact that it is really true, of its serene beauty, of its silent omnipresence throughout the infinite universe of space, of the absolute exactitude and invariance of its truth from everlasting to everlasting—will not fail to yield a sense of reverence and awe akin to the feeling that, for example, pervades this choral prayer by Sophocles:

“Oh! that my lot may lead me in the path of holy innocence of word and deed, the path which august laws ordain, laws that in the highest empyrean had their birth, of which Heaven is the father alone, nor did the race of mortal men beget them, nor shall oblivion put them to sleep. The god is mighty in them and he groweth not old.”

But why should we think it strange that interests, though they seem to cluster about opposite poles, are yet united by a common mood? Of the great world of human interests, mathematics is indeed but a part; but is a central part, and, in a profound

and precious sense, it is "the eternal type of the wondrous whole." For poetry and painting, sculpture and music—art in all its forms—philosophy, theology, religion and science, too, however passionate their life and however tinged or deeply stained by local or temporal circumstance, yet have this in common: they all of them aim at values which transcend the accidents and limitations of every time and place; and so it is that the passionlessness of the merman's thought, the infiniteness of the kind of being he contemplates and the everlastingness of his achievements enter as essential qualities into the ideals that make the glory of the seraph's world. I do not forget, in saying this, that, of all theory, mathematical theory is the most abstract. I do not forget that mathematics therefore lends especial sharpness to the contrast in the Mephistophelian warning:

Gray, my dear friend, is all theory,
Green the golden tree of life.

Yet I know that one who loves not the gray of a naked woodland has much to learn of the esthetic resources of our northern clime. A mathematical doctrine, taken in its purity, is indeed gray. Yet such a doctrine, a world-filling theory woven of gray relationships finer than gossamer but stronger than cables of steel, leaves upon an intersecting plane a tracery surpassing in fineness and beauty the exquisite artistry of frost-work upon a windowpane. Architecture, it has been said, is frozen music. Be it so. Geometry is frozen architecture.

No, the belief that mathematics, because it is abstract, because it is static and cold and gray, is detached from life, is a mistaken belief. Mathematics, even in its purest and most abstract estate, is not detached from life. It is just the ideal handling of the problems of life, as sculpture

may idealize a human figure or as poetry or painting may idealize a figure or a scene. Mathematics is precisely the ideal handling of the problems of life, and the central ideas of the science, the great concepts about which its stately doctrines have been built up, are precisely the chief ideas with which life must always deal and which, as it tumbles and rolls about them through time and space, give it its interests and problems, and its order and rationality. That such is the case a few indications will suffice to show. The mathematical concepts of constant and variable are represented familiarly in life by the notions of fixedness and change. The concept of equation or that of an equational system, imposing restriction upon variability, is matched in life by the concept of natural and spiritual law, giving order to what were else chaotic change and providing partial freedom in lieu of none at all. What is known in mathematics under the name of limit is everywhere present in life in the guise of some ideal, some excellence high-dwelling among the rocks, an "ever flying perfect" as Emerson calls it, unto which we may approximate nearer and nearer, but which we can never quite attain, save in aspiration. The supreme concept of functionality finds its correlate in life in the all-pervasive sense of interdependence and mutual determination among the elements of the world. What is known in mathematics as transformation—that is, lawful transfer of attention, serving to match in orderly fashion the things of one system with those of another—is conceived in life as a process of transmutation by which, in the flux of the world, the content of the present has come out of the past and in its turn, in ceasing to be, gives birth to its successor, as the boy is father to the man and as things, in general, be-

come what they are not. The mathematical concept of invariance and that of infinitude, especially the imposing doctrines that explain their meanings and bear their names—what are they but mathematicizations of that which has ever been the chief of life's hopes and dreams, of that which has ever been the object of its deepest passion and of its dominant enterprise, I mean the finding of worth that abides, the finding of permanence in the midst of change, and the discovery of the presence, in what has seemed to be a finite world, of being that is infinite? It is needless further to multiply examples of a correlation that is so abounding and complete as indeed to suggest a doubt whether it be juster to view mathematics as the abstract idealization of life than to regard life as the concrete realization of mathematics.

Finally, I wish to emphasize the fact that the great concepts out of which the so-called higher mathematical branches have grown—the concepts of variable and constant, of function, class and relation, of transformation, invariance, and group, of finite and infinite, of discreteness, limit, and continuity—I wish, in closing, to emphasize the fact that these great ideas of the higher mathematics, besides penetrating life, as we have seen, in all its complexity and all its dimensions, are omnipresent, from the very beginning, in the *elements* of mathematics as well. The notion of group, for example, finds easy and beautiful illustration, not only among the simpler geometric motions and configurations, but even in the ensemble of the very integers with which we count. The like is true of the distinction of finite and infinite, and of the ideas of transformation, of invariant, and nearly all the rest. Why should the presentation of them have to await the uncertain advent of graduate

years of study? For life already abounds, and the great ideas that give it its interests, order and rationality, that is to say, the focal concepts of the higher mathematics, are everywhere present in the elements of the science as glistening basets of gold. It is our privilege, in teaching the elements, to avail ourselves of the higher conceptions that are present in them; it is our privilege to have and to give a lively sense of their presence, their human significance, their beauty and their light. I do not advocate the formal presentation, in secondary schools, of the higher conceptions, in the way of printed texts, for the printed text is apt to be arid and the letter killeth. What I wish to recommend is the presentation of them, as opportunity may serve, in Greek fashion, by means of dialectic, face to face, voice answering to voice, animated with the varying moods and motions and accents of life—laughter, if you will, and the lighting of wit to cheer and speed the slower currents of sober thought. Of dialectic excellence, Plato at his best, as in "Phædo" or the "Republic," gives us the ideal model and eternal type. But Plato's ways are frequently circuitous, wearisome and long. They are ill suited to the manners of a direct and undeliberate age; and we must find, each for himself, a shorter course. Somebody imbued with the spirit of the matter, possessed of ample knowledge and having, besides, the requisite skill and verve ought to write a book showing, in so far as the printed page can be made to show, how naturally and swiftly and with what a delightful sense of emancipation and power thought may pass by dialectic paths from the traditional elements of mathematics both to its larger concepts and to a vision of their bearings on the higher interests of life. I need not say that such a handling of ideas implies

much more than a verbal knowledge of their definitions. It implies familiarity with the doctrines that unfold the meanings of the ideas defined. It is evident that, in respect of this matter, the scripture must read: Knowing the doctrine is essential to living the life.

C. J. KEYSER

COLUMBIA UNIVERSITY

BENJAMIN FRANKLIN THOMAS

No more unexpected and startling announcement ever came to the writer than that of the death of Professor Thomas last summer. Only a few weeks before he was apparently in rugged health and as much interested as ever in the various phases of his department of science and its applications. The workers die but the work goes on.

Professor Thomas was born at Palmyra, Ohio, October 14, 1850, and died near his summer home in Maine, July 4, 1911. He received his preparation for college under private tutorage in Fox Lake, Wisconsin, and took the degree of Master of Science at Ripon College in 1874. Then followed one year at the Fort Berthold Indian Reservation in Dakota, two years as instructor at Carlton College in Minnesota and three years as a graduate student at the Massachusetts Institute of Technology and research assistant at the Stevens Institute in Hoboken. At this last institution he earned the degree of Doctor of Philosophy in 1880. The next five years he spent as professor of physics at the University of Missouri. In 1885 he was elected to the same chair in succession to Dr. T. C. Mendenhall at the Ohio State University. To this institution he gave twenty-six years of undivided and efficient service in the cause of education. This term of service covered the critical formative period while the institution was evolving from a small "College of Agriculture and Mechanic Arts" into the great state university of the present. His compelling logic, clear mental grasp of a difficult situation, and his exceptional gift for orderly statement made his services of great value in

faculty meetings, in hearings before legislative committees, and as an expert witness in important cases of litigation.

Professor Thomas was early in foreseeing the immense expansion likely to come in applied electricity, and in 1889 he was instrumental in obtaining from the legislature an appropriation for a building and its equipment to accommodate a course in electrical engineering. This was probably the first college building ever built solely for the purpose of teaching this branch of engineering. His foresight has received abundant justification in a number of graduates in this course who have shed luster on their chosen profession and on their alma mater.

Professor Thomas's especial interest was in the subject of electrical measurements and electrical applications. He was unusually successful in developing the courses in advanced electrical measurements for engineering students; and by careful planning and persistent effort, carried on steadily through many years, he succeeded in getting together a magnificent equipment for this work. At the same time he elaborated a strong course of instruction which matched the fine equipment for effective use. He was a remarkably skilful experimenter in the study of rapidly varying electrical phenomena. His oscillograms of electric discharges and of waves of electric pressure and current are the most beautiful the writer has ever seen.

Professor Thomas's practical work as an electrical expert early led him to a thorough study of the photometry of arc and incandescent lamps, and enabled him to give valuable aid in electric lighting to many great institutions of the state, such as the Ohio Soldiers' and Sailors' Orphans Home, the state house at Columbus and the State Hospitals at Athens, Dayton and Toledo. He was for a number of years director of the Ohio Meteorological Bureau before it was merged into the United States Weather Bureau. He was also the representative for the state in the meetings called by the Bureau of Standards in Washington to confer on the subject of correct weights and measures.

Among the public positions filled by Professor Thomas was that of member of the board of examiners at the International Electrical Exhibition in Philadelphia in 1884 and of the Jury of Awards in the Department of Electricity at the Columbian Exhibition in 1893. At the latter he was placed in charge of a very elaborate test of the life and efficiency of incandescent electric lamps. The results of this prolonged test unfortunately were never published by the government. He was an expert judge of electrical instruments, machinery and processes, and he was in consequence much in demand as a consulting engineer to design the electric plants of large establishments.

As a teacher Professor Thomas excelled in the clearness and precision of his statements. These were matched by the success of his experimental demonstrations. From his students he invariably demanded solid, substantial work; he was impatient with careless or slovenly ways either in the class-room or the laboratory, and constantly held up to his classes high standards of attainment.

The new and substantial physics building at the Ohio State University is a monument to his persistent effort and to his good judgment in planning and working out various details for convenience and efficiency. In the work of his department and all that pertained to it he was indefatigable; to it he gave more than the full measure of time and energy.

Professor Thomas was a genial friend; none more so. The writer was favored with that friendship for many years, and he here gladly gives expression to his deep appreciation of all that this friendship meant to him. Only the bereaved wife, the son and the daughter know what it means to lose a faithful husband and a fond father.

HENRY S. CARHART

ATTENDANCE AT GERMAN UNIVERSITIES

THE *Deutscher Universitäts-Kalender* for the summer semester of 1912, which has just been published, contains a table showing the

enrollment of the twenty-one German universities during the winter semester of 1911-12. The table shows that there were in attendance 57,398 students, as contrasted with 57,200 for the preceding summer semester. This is, however, exclusive of 5,563 auditors, who, if added, would run the grand total to 62,961, as against 61,274 during the summer semester. The University of Berlin continues to lead the list with an enrollment of 9,829 matriculated students, of whom over 5,000 are enrolled in the faculty of philosophy, about 2,000 in the faculty of medicine (including pharmacy and dentistry), 2,412 in law, and 427 in Protestant theology. In addition there were in attendance 776 male auditors and 258 female auditors, bringing the total enrollment of the university during the past winter semester to 10,863, as against 10,720 during the winter semester of 1910-11. The Prussian University of Berlin is followed by the Bavarian University of Munich, which had an enrollment of 6,797 matriculated students and 782 auditors. The Saxon University of Leipzig ranks third with 5,170 matriculated students and 925 auditors. The remaining universities rank in point of attendance as follows: Bonn, 4,279; Breslau, 3,113; Halle, 3,112; Göttingen, 2,637; Freiburg, 2,614; Heidelberg, 2,418; Münster, 2,314; Strassburg, 2,298; Marburg, 2,014; Tübingen, 1,994; Jena, 1,831; Königsberg, 1,694; Kiel, 1,661; Würzburg, 1,583; Giessen, 1,428; Erlangen, 1,251; Greifswald, 1,228; Rostock, 955; the figures in each case being inclusive of auditors. During the winter semester of 1893-94 the universities ranked as follows: (1) Berlin, (2) Munich, (3) Leipzig, (4) Halle, (5) Würzburg, (6) Bonn, (7) Breslau, (8) Tübingen, (9) Erlangen, (10) Freiburg, (11) Heidelberg, (12) Strassburg, (13) Marburg, (14) Göttingen, (15) Greifswald, (16) Königsberg, (17) Jena, (18) Giessen, (19) Kiel, (20) Rostock, and (21) Münster. It will thus be seen that there has been no change in the order of the three largest universities, but that several institutions which were in the lower half of the list eighteen years ago, have grown sufficiently to advance

them into the first division, notably Münster, Strassburg and Göttingen.

Of the 57,398 matriculated students, 2,853 were registered in Protestant theology, 1,770 in Catholic theology, 11,632 in law, 13,870 in medicine, and 27,273 in the faculty of philosophy. In addition there were 3,824 male auditors and 1,739 female auditors. In addition to the female auditors there were 2,796 matriculated women in attendance, as against 2,551 during the summer semester of 1911; 2,126 of these were registered under the faculty of philosophy, 600 in medicine, 65 in law and 5 in theology.

Of the 57,398 matriculated students, 52,435 came from Germany, while 4,417 came from other European countries, 338 from America, 175 from Asia, 28 from Africa and 5 from Australia. The largest delegations from European countries hailed from Russia (2,211), Austria (842), Switzerland (341), Roumania (166), Great Britain and Ireland (160), Bulgaria (153) and Greece (98). Berlin attracts by far the largest number of foreign students, namely, 1,536, being followed by Munich (752), Leipzig (697), Halle (320), Heidelberg (215), Königsberg (203), Göttingen (172) and Breslau (160).

R. TOMBO, JR.

THE MEDICAL SCHOOL OF THE UNIVERSITY OF ILLINOIS

THE University of Illinois undertook some years ago in the city of Chicago an experiment in the work of medical education. As it had received no grant from the legislature for the erection of a plant, it leased the buildings, ground and equipment necessary for the use of a medical school from the College of Physicians and Surgeons in the city of Chicago. The rental paid for this property was very reasonable, not exceeding, in fact, the fixed charges of the plant, counting in the interest on the mortgages and bonds and the requirements of the sinking fund. The school has been conducted for some fifteen years under this general arrangement, with details varied from time to time. During that period the school has been greatly improved, and ranks

to-day among the good American medical schools.

The University of Illinois, however, has never expended upon this school or its management or in rent for the use of the property, a single dollar from the state appropriations. It has been limited to the use of the fees paid by students. The claim may be fairly made that no better school, conducted on the basis of student fees alone, can be found in the country. The time has come, however, when no medical school can be maintained in accordance with modern standards, whose only support is derived from the payment of fees by students. Recognizing this fact, and unwilling to conduct an inferior school, the university has asked the legislature upon three different occasions for funds to put the school upon a proper basis. The legislature granted at one time the sum of \$389,000 for the purpose of providing an adequate plant for the use of the medical school. The governor, however, vetoed this bill. In answer to the last request from the university, the legislature granted (at the 47th Session) for the present biennium, the sum of \$60,000 per annum for the equipment, maintenance and extension of the college of medicine of the University of Illinois. This appropriation was lost by the recent decision of the Supreme Court that it was unconstitutional, owing to the fact that the provision in the bill making this appropriation had been amended in the conference committee without having been printed.

The university now renews its request to the General Assembly for an appropriation for the equipment, maintenance and extension of its work in medicine and public health. The College of Physicians and Surgeons, however, has decided not to renew to the university the lease for the use of its present plant in the city of Chicago when it expires on June 30, 1912.

Owing to the fact that there is no other adequate plant in the city of Chicago which can be obtained for the use of a medical school, at a reasonable rental, the board of trustees of the university have been compelled to announce the closing of the medical

work in Chicago. They have decided to develop the medical work already begun at the site of the university in Urbana-Champaign.

To carry on this enterprise a special building is absolutely necessary, since there is no available space to house such work in the buildings now upon the campus, or in those authorized to be erected by the present legislature.

The trustees of the University of Illinois, therefore, have asked the general assembly to appropriate at its special session the sum of \$250,000 for the development of its work in public health and medicine at Urbana-Champaign. The greater part of this money will be used for the erection, furnishing and equipment of a medical building. It is proposed to organize those fundamental courses in medicine and public health which should be required by all schools of medicine, and which every physician, no matter what method of practise he may adopt, must be presumed to know, such as physiology, bacteriology, histology, anatomy, pathology and sanitation.

SCIENTIFIC NOTES AND NEWS

At the meeting of the National Academy of Sciences, held in Washington on April 18, new members were elected as follows: R. W. Wood, professor of experimental physics at the Johns Hopkins University; Harry Fielding Reid, professor of geological physics at the Johns Hopkins University; David White, geologist, U. S. Geological Survey; Roland Thaxter, professor of cryptogamic botany at Harvard University; Chas. B. Davenport, director of the Station for Experimental Evolution, Cold Spring Harbor, N. Y.; W. M. Wheeler, professor of economic entomology at Harvard University; John J. Abel, professor of pharmacology at the Johns Hopkins University; S. J. Meltzer, head of the department of physiology and pharmacology of the Rockefeller Institute for Medical Research.

THE committee on policy of the American Association for the Advancement of Science held meetings at Washington on April 16 and 17. There were present Mr. Minot, chairman

of the committee; Mr. Pickering, president of the association; Mr. Woodward, treasurer; Mr. Howard, permanent secretary, and Messrs. Cattell, Humphreys and Noyes. Various questions were considered, more especially the division of the association into sections, the relation of the sections to the affiliated societies and the program for the Cleveland meeting.

AMONG the many victims of the terrible disaster to the *Titanic* on April 15, were the following members of the American Association for the Advancement of Science: Mr. Edgar J. Meyer, the well-known mining engineer of New York, who joined the association at the second Baltimore meeting in 1908. Colonel John Jacob Astor who, as is well-known, was greatly interested in mechanical and engineering problems, and who joined at the third New York meeting in 1906. Mr. Frank D. Millet, the well-known artist of Washington, New York and London, who joined at the same meeting as did Colonel Astor. Mr. Millet's interest in science was great and was intensified by his long association with the scientific men in the Cosmos Club of Washington. Dr. Howard, the permanent secretary of the association relates the following anecdote of Mr. Millet: At the time of the meeting of the International Congress of Zoology at Washington in 1907, following the Boston meeting, Dr. Howard was dining one night at the Cosmos Club with Geza Horvath, of the Natural History Museum of Budapest, and G. Severin, of the Natural History Museum of Brussels. As Millet entered the room, he was called over since his knowledge of foreign languages was great and he was much interested in the foreign visitors. He was introduced and at once saluted Horvath in excellent Hungarian; then turning to Severin, instead of speaking to him in French as one naturally would do to a visitor from Brussels, addressed him in Flemish, having, with his artistic eye, noted his apparent descent. Both foreigners were greatly charmed and became at once interested in the man and have always sent greetings to him in their later letters to Dr. Howard.

DR. PAUL G. FREER, director of the United States Government Scientific Bureau in the Philippines and previously professor of chemistry in the University of Michigan, died at Beguio on April 17, at the age of forty-nine years.

THE letters of the late Professor William James are being collected for biographical purposes. Those who have any of his letters can render assistance that will be highly appreciated by addressing Mr. Henry James, Jr., 95 Irving Street, Cambridge, Mass. Casual or brief letters may have an interest or importance not apparent to the person preserving them; and news of the whereabouts of such letters will be gratefully received.

MR. A. D. HALL, F.R.S., has resigned from the directorship of the Rothamsted Experiment Station.

PROFESSOR H. F. NEWALL, F.R.S., has been elected a member of the Athenæum Club for distinguished eminence in science.

PROFESSOR PAUL WALDEN, of Riga, has been elected an honorary member of the Chemical Society, London.

At the annual meeting of the Harvey Society, held on April 10, the following officers were elected for 1912-13:

President—Frederic S. Lee.

Vice-president—William H. Park.

Treasurer—Edward K. Dunham.

Secretary—Haven Emerson.

Additional Members of the Executive Committee

—S. J. Meltzer, Graham Lusk, W. G. McCallum.

THE *Journal of the American Medical Association* states that a dinner was given to Dr. Ludvig Hektoen at the Chicago Club on April 11 by the faculties of Rush Medical College and the College of Physicians and Surgeons and his former students at these institutions, in honor of the twenty-first anniversary of his entrance into the practise of medicine. Dr. Frank Billings presided. An oil-painting of Dr. Hektoen was presented to him by his friends, the presentation speech being made by Dr. E. R. Le Count. Professor E. O. Jordan and Drs. H. Gideon Wells and James B. Herick responded to toasts.

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, is installing a hall of European prehistoric anthropology for the American Museum of Natural History, New York.

DR. J. N. ROSE, who has recently been appointed research associate in the Department of Botanical Research of the Carnegie Institution, sailed for Europe on April 17, where he goes to investigate cactus collections in the various botanical gardens of England, France, Italy and Germany. He will be away about two months. His European address will be: Royal Botanic Gardens, Kew, London, England.

PROFESSOR G. FREDERICK WRIGHT, professor emeritus of geology at Oberlin College, president of the Ohio State Archeological and Historical Society, is carrying on a systematic investigation of the Ohio mounds. At present the society is erecting two buildings of importance, one at Columbus, costing \$100,000, to serve as a general library and museum, the other at Fremont, costing \$40,000, to hold the library of Americana left by the late President Rutherford B. Hayes. Professor Wright has in press a volume on "The Origin and Antiquity of Man," which will appear in July.

ON March 27 Dr. Samuel W. Williston, professor of paleontology in the University of Chicago, delivered an address to the students of the Kansas State Agricultural College, at Manhattan. Coincidentally this date was the fortieth anniversary of his graduation from the college. On this date also he matriculated his youngest daughter in the domestic science department of the college. On March 29 Professor Williston delivered a lecture on the "Evolution of Early Vertebrates" to a special meeting of the College Science Club.

At the annual meeting of the Michigan Academy of Science, held at Ann Arbor March 27-29, the principal address was delivered by Professor Albert A. Michelson, of the University of Chicago. The subject of the address, which was illustrated, was "Iridescent Colors in Birds and Insects." Professor E. C. Case, of the University of Michigan, was elected president of the academy.

THE lecture on "North American Deserts" given by Dr. D. T. MacDougal before the Royal Geographical Society of London in December was repeated by him on request before the four branches of the Royal Scottish Geographical Society in Dundee, Aberdeen, Edinburgh and Glasgow during the first week in April.

PROFESSOR FREDERIC S. LEE, of Columbia University, lectured before the International Y. M. C. A. Training School at Springfield, Massachusetts, on April 12, on "Some Aspects of Muscular Action."

DR. FRANK D. KERN, of Purdue University, gave an illustrated lecture on April 15 before the local Academy of Agricultural Science on the "Floral and Scenic Features of Colorado." A number of seasons spent in studying the plant rusts of that state supplied the basis for the lecture.

PROFESSOR FRANCIS E. LLOYD has recently lectured before the botanical seminar of the Johns Hopkins University on some of his recent work on the tannin content of the acorn (*Quercus laurifolia*). Somewhat later he lectured also before the students of the department of biology, Teachers College, Columbia University, on recent advances in the teaching of botany.

UNDER the auspices of the department of geology two lectures by Professor Isaiah Bowman, of Yale University, were on April 4th delivered at the University of Michigan. The subjects of these lectures were: "The Mountains and Deserts of Bolivia" and "Geographical Explorations in the Peruvian Andes."

DR. IRVING A. FIELD, special investigator for the U. S. Bureau of Fisheries, lectured at Trinity College on the evening of April 18, on the subject "Utilization of Hitherto Unused Marine Organisms as Food."

DR. MARIE STOPES has given a course of ten lectures on the general and geological aspects of paleobotany at University College, London. It was the first course on this aspect of the subject to be given in London.

ON the evening of March 29, the Pennsylvania Chapter of the Society of the Sigma Xi was addressed by Professor William J. Gies, College of Physicians and Surgeons, Columbia University, on the subject, "Chemistry in the Service of Biology." Professor Gies reviewed the history of biological chemistry, explained the problems now being attacked by biological chemists and outlined the problems still open for investigation.

At the Washington birthday celebration of the University of Pennsylvania it was announced that a donation had been received to endow "The Leidy Memorial Lecture in Science" in memory of the late Professor Joseph Leidy.

WE learn from *Nature* that the Essex Field Club has recently appointed a committee for the purpose of raising a small fund to put in order the tombs of John Ray and Benjamin Allen (which stand adjacent to one another in the churchyard at Black Notley, but have been allowed to fall into disrepair), and to erect at Braintree a memorial to Samuel Dale, of that town, to whom no memorial exists. These three naturalists were friends and contemporaries, living at Braintree or in its immediate vicinity in the closing years of the seventeenth century and the opening years of the eighteenth.

DR. EDWARD DIVERS, F.R.S., emeritus professor of chemistry in the University of Tokyo, died on March 8, aged seventy-five years.

DR. A. PACINOTTI, professor of physics at Pisa, has died at the age of seventy-one years.

THE U. S. Civil Service Commission announces an examination on May 8, to fill vacancies as they may occur in the position of scientist in soil survey, at a salary of \$1,600 per annum, in the Department of Agriculture, for duty in the field.

THE Columbia Chapter of the honorary Society of Sigma Xi held its annual initiation and banquet on April 4. At the initiation ceremonies, the 36 new members elected to the society were welcomed by the president of the chapter, Professor George F. Sever.

He explained the origin and purpose of the society, and introduced Professor Henry S. Munroe who spoke on the "Significance of Sigma Xi." At the banquet which followed at the university, representatives were present from the chapters at Cornell, Yale and Pennsylvania.

Mr. C. W. LENG has put his valuable collection of "long horned" beetles at the disposal of the American Museum of Natural History for use in filling gaps in its collections. This means a gift of some 870 specimens covering nearly 300 species not hitherto acquired. Mr. John A. Grossbeck, who has been specializing for some time on the Geometridæ, has given to the museum his entire collection of these moths in addition to the series previously donated.

WE learn from *Nature* that the sixty-fifth annual general meeting of the Paleontographical Society was held in the Geological Society's rooms at Burlington House on March 22, Dr. Henry Woodward, F.R.S., president, in the chair. The annual report referred to the completion of the monograph of English Chalk fishes, and of the second volume of that of Pleistocene mammalia. It also acknowledged the help of the Carnegie Trust for the universities of Scotland in providing the plates for another instalment of Dr. Traquair's monograph of Carboniferous palæoniscid fishes. A special effort had been made to complete works in progress before beginning new undertakings. Miss Margaret C. Crosfield, Mr. George Barrow, Mr. H. R. Knipe and Professor W. W. Watts were elected new members of council. Dr. Henry Woodward, Dr. George J. Hinde and Dr. A. Smith Woodward were reelected president, treasurer and secretary respectively.

THE natural history library of the University of Illinois has been enriched by the addition of a set of *Flora Brasiliensis*, in forty folio volumes and costing \$1,500. The set is written in Latin and is said to be the fourth obtained by American libraries, others being at Harvard, Columbia and the Shaw Botanical Gardens.

It is stated in *Nature* that the whole of the famous collection formed by the Rev. Canon Norman, F.R.S., consisting of North Atlantic and Arctic invertebrates other than insects, arachnids and myriopods, has now become the property of the Natural History Museum, the fourth and last instalment having been received recently at Cromwell Road. Of Mollusca there were specimens in 7,114 glass-topped boxes, of Crustacea there were 7,376 bottles and tubes containing specimens, and there were, in addition, 5,544 microscopical slides. The Polyzoa were contained in 1,063 glass-topped boxes, while there were 497 spirit specimens and 185 microscopical slides. The "lower invertebrata" were numerous represented in the earlier instalments.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Chicago has established a system of retiring allowances for professors or their widows. A fund of \$2,500,000 taken from the \$10,000,000 Rockefeller gift of 1910 has been set aside for this purpose. This pension system will grant to men who have attained the rank of assistant professor or higher, and who have reached the age of sixty-five, and have served fifteen years or more in the institution, 40 per cent. of their salary, and an additional 2 per cent. for each year's service over fifteen. The plan also provides that at the age of seventy a man shall be retired unless the board of trustees specially continues his services. The widow of any professor entitled to the retiring allowance will receive one half the amount due him, provided she had been his wife for ten years.

At Princeton University a fund of \$5,000 has been established by Mr. Albert Plaut, of New York, for the purpose of encouraging the study of chemistry, especially by securing distinguished chemists to address the Chemical Club; and the Louis Clark Vanuxem foundation has been established by a bequest of \$25,000, under the will of Mr. Vanuxem, for the support of a series of lectures at Princeton annually, at least one half of which must be

upon subjects of current scientific interest. It should have been stated in the last issue of *SCIENCE* that the gift of \$300,000 to Princeton University from Mr. W. C. Procter for the establishment of fellowships was part of his gift of \$500,000, the balance having been used for the construction of a memorial dining hall in the Graduate College.

Mrs. H. M. BERNARD, of London, has arranged with Professor Kellogg who is at present in London, to establish a small scholarship in the department of entomology at Stanford, to aid an advanced student for two years in an investigation of some problem in insect evolution. The scholarship will yield one hundred dollars a year besides an additional sum to pay all laboratory fees. Mrs. Bernard is the widow of the English biologist Henry M. Bernard, a student of Ernst Haeckel, at Jena, an authority on the corals and an independent investigator of evolution problems. "Mrs. Bernard has recently edited and published many of her husband's notes in a book called "Some Neglected Factors in Evolution" (Putnam's). She has already established an evolution scholarship in the University of London, and expects to found others in three or four American universities.

THE library of the department of botany, Brown University, has received a gift of 150 volumes of rare botanical books, valued at \$2,000, in memory of the late Edward P. Taft, class of '54.

GOVERNOR DIX has signed the Harte bill providing for the establishment of a New York State School of Agriculture on Long Island and appropriating \$50,000 for that purpose. He says in a memorandum that plans should be formed and put into effect for the training of qualified agricultural teachers in one or more of the state normal schools and that an effort should also be made toward the introduction in the public high schools of at least the elementary study of agriculture.

PROFESSOR HENRY B. FINE has resigned the deanship of the faculty of Princeton University but continues as dean of the departments

of science and as Dod professor of mathematics. He has been granted a leave of absence for the next academic year which he will spend in Europe. Dr. William F. Magie, Henry professor of physics, has been elected dean of the faculty to succeed Professor Fine.

DR. ALFRED M. TOZZER has been appointed assistant professor of anthropology at Harvard University.

DR. GILBERT N. LEWIS, research professor of chemistry in the Massachusetts Institute of Technology, has been appointed professor of physical chemistry in the University of California, succeeding the late Willard B. Rising. Dr. H. W. Morse, now of Harvard University, becomes lecturer in chemistry. In the same institution Dr. S. J. Holmes, of the University of Wisconsin, has been appointed associate professor of zoology. The last appointment is made to fill the vacancy caused by the removal of Professor H. B. Torrey to Reed College.

DISCUSSION AND CORRESPONDENCE

PHENOTYPES, GENOTYPES AND GENS

WHILE there should be no objection to weekly revisions of the vocabulary of genetics, if any useful purpose is served, some readers of *SCIENCE* may share in the belief that special terms can have little practical value unless they continue to bear the same or closely related meanings. The word phenotype, for example, seems to have been employed by Professor Johannsen as a statistical term, for a purpose essentially different from that illustrated in Dr. Shull's recent paper, in *SCIENCE* of February 2, 1912, p. 182. Dr. Shull assures us of Professor Johannsen's authority for the new version of phenotype, but this does not destroy the historical interest of previous revelations.

To show the distinction that phenotype once conveyed, a free translation of Johannsen's most direct statement may be given:

Thus we recognize that the "type" in the Queletian sense is merely a superficial appearance which may be deceptive; only through further investigation can it be determined whether one or many biologically different types are present.

Therefore it would be proper to designate the statistically prominent type as an apparent type (*Erscheinungstypus*), or, more briefly and directly, a phenotype (*Phänotypus*). Such phenotypes are in themselves measurable realities; something that can be observed as typical; that is, the centers among series of variations, around which the variants are grouped. The word phenotype serves only to make the necessary mental reservation that from the appearance alone no further conclusion can be drawn. A given phenotype may be an expression of biological unity (*Ausdruck einer biologischen Einheit*), but it does not at all need to be. Indeed, this is not true, in a great majority of cases, of the phenotypes found in nature by statistical investigations of variations.¹

Of course it would be presumptuous to assume that any translation would convey the exact meaning of such a passage, but at least it can be seen that phenotype was being used by Johannsen as a concrete collective term, and not merely as an abstract conception, as Shull has supposed:

"Phenotype" and "genotype," when both are rightly used, are *contrasted terms*, both being *abstractions* referring to the *type* to which an individual or group of individuals belongs, and *not to the group of individuals* belonging to that type. To illustrate the use of "phenotype" in its correct sense, reference may be made to the F_2 of a Mendelian hybrid.²

When the phenotype idea was brought later on into direct contrast with the genotype idea, the two were compared as abstractions, but this conceptual refinement was for purposes of explanation and did not necessarily supplant the more concrete application of phenotype previously made. Shull need not apologize for himself or for Jennings on account of having used phenotype in a concrete sense. It may be that the first use of the term, as restricted to the statistically prominent center of the group, was too narrow for convenience, but any group that has been found to show a statistical unity could be described at least as phenotypic.

¹Johannsen, W., "Elemente der Exakten Erblichkeitslehre," p. 123.

²Shull, G. H., "'Phenotype' and 'Clone,'" SCIENCE, N. S., Vol. XXXV., February 2, 1912, p. 182.

That Johannsen did not contemplate the employment of "genotype" in any such concrete sense as phenotype seems plain from the statement that accompanies his definition:

Very obvious phenotypical differences may be shown where no genotypical difference is present; and there are also cases where with genotypical diversity the phenotypes are equal. Just for this reason it is of the greatest importance to separate clearly the conception phenotype or apparent type (*Erscheinungstypus*) from the conception genotype or germ-type (*Anlagetypus*), as one might say. With this latter conception, to be sure, we shall not be able to work (*nicht operieren können*)—a genotype does not make its appearance in pure form (*tritt eben nicht rein in die Erscheinung*); but the derived concept of genotypical difference will be of use in manifold ways.

Phenotypes, as we learned from the previous quotation, are found in nature, but genotypes are not. To the unregenerate reader Johannsen's genotype appears to be nothing more than an unframed conception of a germinal or genetic constitution, considered as something apart from the external manifestation of the characters. It is an indirect and complicated substitute for the old distinction between latent and patent characters, between transmission and expression.

To replace the word genotype because it was preoccupied in taxonomic biology may not seem so necessary if it be considered merely as the name of an abstract conception with no real existence that needs to be discussed in biological literature. But that geneticists should wish to keep the word in active use as a major term after its previous history has been pointed out is only one more way of showing disregard for the taxonomic framework of biology.

The adjective use of genotype is hardly more fortunate than the substantive application. Why we should say genotypical differences instead of genetic differences or germinal differences is not obvious, but perhaps the longer word means more to geneticists. If the object was to keep closer to the idea of a germinal constitution made up of separate units or gens, the meaning could have been

conveyed more effectively by speaking of *genic* differences than by adding extra syllables. The "type" part of Johannsen's words has served only to confuse the issues, as in the passage where Shull says that phenotypes and genotypes are abstractions relating to types but not to groups. How can there be typical differences, in any biological sense, unless groups are compared? The fact seems to be that Johannsen was not using the word type in accord with biological traditions, but in a loose metaphysical way that renders the terms more abstract instead of more concrete.

There should have been no difficulty in finding suitable names for the two classes of Mendelian hybrids that Shull has pointed out, instead of allowing them to become confused with Johannsen's genotypes and phenotypes. As the so-called genotypes are supposed to have the same gens, they could be described as isogenic hybrids or isogens. Any group treated as having biological unity may be called an isogen. Johannsen approached the idea of biological unity in the passage explaining the use of phenotype, but did not provide a name for such groups except indirectly through the genotype concept.

The hybrids that have different germinal constitutions, and yet look alike, could be described as isophanic hybrids or isophans. They have the same dominant characters, but this does not involve any complete statistical or phenotypic unity. The groups are formed with reference to alternative, Mendelian characters, instead of on the basis of statistical measurements of continuous variations. As Johannsen pointed out, even genotypical unity does not preclude phenotypical differences.

Pluralizing the word *gen* is another difficulty encountered by geneticists. Johannsen used the term mostly in its German plural form, *Gene*. Our writers have added another letter making a double plural, "genes," something like "memorandas."

Johannsen proposed *gen* as a simplification of Darwin's term *pangen*, to avoid the implications of Darwin's theory of pangenesis:

Instead therefore of *pangen* (*das Pangen*) and

pangens (*die Pangene*), we shall simply say *gen* (*das Gen*) and *gens* (*die Gene*).

Along with this word *gen*, to represent an invisible rudiment or transmitted germ of a character, it will be useful to have a corresponding term, *phan*, to represent an external manifestation or expression of a character. To be able to refer to the external expression or phanic relations of characters is quite as important as to discuss them from the standpoint of theories of transmission. From these two roots it will be easy to develop a simple and appropriate terminology for many of the facts of heredity.

O. F. COOK

WASHINGTON, D. C.,
February 24, 1912

CROSS CUTTING AND RETROGRADING OF STREAM-BEDS

In the October (1911) number of the *American Journal of Science*, I read with interest an article by Mr. John Lyon Rich on "Recent Stream Trenching in the Semi-arid Portion of Southwestern New Mexico, a Result of Removal of Vegetation Cover," on which I have ever since intended making brief comment, because it seemed to me Mr. Rich presented only one phase of the subject. While the stated factor, "removal of vegetation cover," may in some localities, accelerate the retrograding (trenching) of stream-beds, it is not, in my opinion, the cause of retrograding. I noted the same characteristics (and others probably also noted) years ago in places where there were no cattle and never had been any.

The "trenching," Mr. Rich says, "is still in progress," which is true, for it has always been and always will be, in progress, cattle or no cattle, vegetation or no vegetation, not only in semi-arid regions but everywhere. There are differences in degree and rate—that is all—and in arid regions the rate is conspicuous.

There are two forces at work wherever water runs or ice flows, which, so far as I know, have not been sufficiently defined up to the present. They are *cross-cutting* and *retro-*

grading of stream-beds. They are close companions and they are among the chief causes of degradation in any region, being more noticeable in mountainous semi-arid regions because inequalities of stream flow are greater in such regions.

Every water course (or glacier course) is subject to cross-cutting, on a greater or smaller scale according to conditions. In semi-arid lands it is often violent.

Take a stream flowing in a semi-arid region over the surface of a sedimentary deposit of say 20 feet in depth. This stream bed terminates in some other stream bed which may be dry most of the time, the water of the first evaporating or seeping away before the junction is reached. For some reason this master-stream corrodes its bed more rapidly than the tributary—by sudden flood, perhaps, in which the tributary does not share. The tributary stream bed is cut away at the junction, leaving it high above the bed of the master-stream—the water, if there is any at this point, cascades. The tributary enters by what has been termed a hanging-valley. The process of retrograding then begins in the tributary stream-bed. It is a process of corrosion by undercutting. It may be slow or fast, depending on many conditions. In arid and semi-arid regions, banks of dry earth often remain vertical for years. This is partly because the surface behind the wall (as pointed out by Stanton in his investigation of the landslides on the Canadian Pacific Railway) becomes impervious to water and, like a roof, prevents the earth mass from becoming saturated. Even when chunks of this earth fall beside a stream they do not readily disintegrate unless completely submerged, because the clay forms on their surface an impervious coating. I have seen earth-cliffs 30 to 40 feet high with all the characteristics of a rock-cliff erosion. The run-off is quick. Steady rains are infrequent. The earth mass can not become saturated. But given an abnormally steady and long-continued rainfall, in combination with a "cloud-burst," at the headwaters, and all is changed with startling rapidity. It is dramatic. The tributary

flood undercuts its precipice steadily and mass upon mass of the earth drops into the flood to dissolve. The precipice travels up stream.

The tributary stream-bed is immediately placed on a par with its master. When the storm is over the precipice of earth if found at all is found miles towards headwaters. The former stream instead of flowing on the surface amidst verdure and willows and cottonwoods, now glides at the bottom of a desolate and barren earth canyon.

In the retrograding it has cross-cut the mouths of other stream-beds, where in time, the operation described is repeated over and over, as the country is gradually lowered by these forces.

There have been many excellent examples of cross-cutting and of violent retrograding, two of which I may mention. In the 60's of the last century one occurred at the little Mormon settlement of Santa Clara in south Utah. In a single night the stream was metamorphosed. At Kanab, south Utah, a similar example took place about 1900. In an astonishingly brief time the Kanab creek meandering amongst willows and vegetation was transformed into a waste for miles of its course. The channels through which the Colorado River broke into the Imperial Valley exhibited retrograding in its violent form and excellent photographs were made at the time.

In the Mukuntuweap Valley in southern Utah cross cutting and retrograding in rock may be studied. Some small valleys that were cross-cut ages ago remain almost unaltered. They hang 1,000 feet above the master-stream. The explanation seems to be that during the Glacial Epoch the high plateaus at the headwaters of the Virgin river were heavily piled with snow and ice which, melting in the summers, carried on rapidly the work of corrosion in the main streams which had sources in the very high lands, while the shorter stream-beds with lower sources were even then arid and were left behind, having no power of retrograding to keep level with master streams. In other words the corrosion of the master-streams ran away from the erosion of the drier valleys, leaving the latter hanging

in the air. The process is the same as when earth is concerned.

F. S. DELLENBAUGH

226 W. 78TH ST.,

NEW YORK,

March 29, 1912

REPORTED DISCOVERY OF RADIUM IN NORTHERN
ARKANSAS

IN this day, new results of scientific work make such rapid appearance that the public in general are very credulous about reported discoveries however unreasonable they may appear, and even scientists are cautious about expressing adverse opinions concerning such, without having carefully investigated them. Apropos of this, a short article that some weeks ago appeared in a St. Louis paper, reporting an alleged discovery of radium in northern Arkansas and naming the writer as authority for its existence, has been somewhat widely copied by the press, and has brought numerous letters to the writer from different parts of the country from New York to California. Among these have been letters from scientists and those engaged in commercial work. The foundation for the report is as follows:

In the latter part of February there came to the writer's office, then at the University of Arkansas, a Mr. Leib, of Bentonville, that state, who brought a cigar box of earthy material which he said came from a cave near his home. It was just such material as might come from any limestone cave. With the box was a photograph which Mr. Leib said had been made by exposing the box containing the material before a camera, for several hours, in an absolutely dark room. The picture was of about the distinctness of an ordinary X-ray photograph. It plainly showed the box, the string about it and the knots in the string.

Mr. Leib was told by both Professor A. A. Steel, of the University of Arkansas, and myself that while the photograph was interesting, careful investigation was necessary before it could be stated that the substance contains any radium or other radio-active material. For this purpose he was advised to

send some of it to Professor B. B. Boltwood, of Yale University.

Such is the basis of a newspaper story that seems to have attracted a good deal of attention.

A. H. PURDUE

STATE GEOLOGICAL SURVEY,

NASHVILLE, TENN.,

April 17, 1912

THE AMERICAN ASSOCIATION FOR THE ADVANCE-
MENT OF SCIENCE

TO THE EDITOR OF SCIENCE: It is generally agreed that the recent Washington meeting of the American Association for the Advancement of Science and its affiliated societies was one of the most enjoyable, helpful and inspiring meetings ever held in this country. The attendance was large, the programs well filled, the discussions earnest and the efforts of the local committees fully successful in providing ample means for social intercourse without too much distraction from the work of the meeting.

Nevertheless, that meeting probably marks the parting of the ways, and it behooves all of us who have been and still are loyal to the American Association for the Advancement of Science to give earnest consideration to the question of the future policy of that union of scientific workers which has in the past done so much to deserve its title.

Two of the fundamental principles of the association are: first, by means of migratory meetings to arouse interest in scientific matters in different sections of the country; second, to bring together workers in all branches of science, for mutual acquaintance and for the development of broader view-points than is possible from too close absorption in one's own special line.

These ideals could be and have been well realized in the past when the average attendance on such meetings was not too large for the hotel accommodations of most of our cities and when it was usually possible to have meetings of various sections in one building, thus enabling closely related sections to meet in adjacent rooms.

But that day has passed. Organization among scientific workers has increased at a tremendous pace during the past few years, largely through the energy of the officers of the organizations of special branches of science. The growth from two thousand to almost six thousand in the membership of the American Chemical Society within the past four years is only typical of the relative activity in other societies.

With such an increase in organization membership it has now become a physical impossibility to longer realize the old ideals of the American Association for the Advancement of Science, and so we hear more and more of withdrawal movements. The example of the zoologists, naturalists and anatomists, during the last convocation week is going to be more and more followed by other societies.

Does this mean the dismemberment of the American Association for the Advancement of Science, the giving up of the opportunity to come in touch with fellow workers in allied sciences, the loss of a national association of organized science? Truly this would be a calamity.

Can such a calamity be avoided?

In the hope of at least provoking discussion, the following suggestions are submitted, in full realization of their imperfections, but nevertheless, as based upon an honest effort to look the situation squarely in the face.

First. Let the American Association for the Advancement of Science lend all of its aid and sympathy to the development of the affiliated societies.

Second. Let the American Association for the Advancement of Science give up its present annual meetings and instead hold triennial or quadrennial meetings.

Third. Let the affiliated societies in turn give up their regular meetings at the time of the American Association for the Advancement of Science meetings and lend all of their influence towards making these meetings great national gatherings of scientists.

Fourth. Let the migratory meetings of the affiliated societies serve the purpose of arousing local public interest in scientific work.

Fifth. Let the meetings of the American Association for the Advancement of Science be held in the national capital, at a time when Congress is not in session and hotel accommodations consequently ample.

If such a policy could be agreed upon by all, the American Association for the Advancement of Science could well afford to give up its charge of an initiation fee from all who are members of affiliated societies. Further, in view of the decreased administrative expense and largely increased membership the present annual dues might possibly be still further reduced.

Such truly national gatherings of scientific workers would be inspiring to all of us, and would make a national impress, as the best conditions would there prevail for the formulation of scientific policies of nation-wide importance.

To carry out the above plan no very great practical difficulties would have to be overcome. The changes are not radical, but evolutionary in character. It is hoped that the suggestions may be of some service.

CHAS. H. HERTY

UNIVERSITY OF NORTH CAROLINA

SCIENTIFIC BOOKS

Bacteria in Relation to Plant Diseases. By ERWIN F. SMITH, in charge of laboratory of plant pathology, Bureau of Plant Industry, U. S. Department of Agriculture. Volume II., History, General Considerations, Vascular Diseases, Washington, D. C. Published by the Carnegie Institution of Washington. 1911. Pp. viii + 368. Quarto. Publication No. 27, Vol. two.

Somewhat more than six years ago the writer of this notice had the pleasure of publishing a note (SCIENCE, Nov. 24, 1905) in regard to the first volume of this work, and there expressed the hope that the publication of the second volume would "not be long delayed." But good and sufficient reasons for the delay are given in the introduction to this volume, where we are told that it is "based in great part on data obtained as the result of a

multitude of experiments made by the writer and his assistants" and that "it has often happened that the ink on some chapters would scarcely be dry before the results obtained from new experiments would require some part of it to be rewritten." We are further told that in this way some chapters were "rewritten a dozen times, in whole or great part." These quotations will serve also to give some idea of the method of science, and of the infinite pains which must be taken before final results are attained.

As indicated by the title of this volume, it deals with the history of the subject, that is, with the successive investigations of workers in this field of science. Some of the pronouncements of the earlier pathologists now make "mighty interesting reading," as shown by the quotations which are liberally given on pages 9 to 20. Then follow nearly two hundred pages of "general considerations" in which are discussed such questions as "the supposed normal occurrence of bacteria in plants" (which is decided in the negative); "bacteria on the surface of plants"; "parasitism"; "inception and progress of the disease"; "reaction of the plant"; "symbiosis," etc. The remainder of the book (about 150 pages) is devoted to "Vascular Diseases," that is, the diseases which have to do with the vessels of plants.

Three vascular diseases are fully discussed, namely, the "Wilt of Cucurbits," the "Black Rot of Cruciferous Plants" and the "Yellow Disease of Hyacinths." These are severally due to the invasion of the tissues by *Bacillus tracheiphilus* Smith, *Bacterium campestris* (Pammel) Smith, and *Bacterium hyacinthi* Wakker. As one reads the pages of descriptions he is impressed with the thoroughness with which the work upon which they are based was done. At every step one sees the results of the most painstaking investigation, much of which extended through many years. And with it there grows the feeling that here at last we have contributions to plant pathology that rest upon solid foundations and from which guesses and inferences have been wholly omitted.

In the introduction (page 4) we are given a convenient grouping of the diseases of plants due to bacteria, viz.: (1) The vascular diseases, (2) the parenchyma diseases without hyperplasia and (3) cankers, tubercles and tumors in which there is a more or less distinct hyperplasia. It will appear from this that the author has treated but one type or group of diseases, and from this we may infer that this volume is to be followed by one or more others, although no hint is given us by the author as to his intentions. It is to be hoped that Volume III. will appear in due time and that if this be not enough still others may follow. We can not help wishing that the plant diseases due to the fungi might find an investigator who would do for them what Dr. Smith is doing for those due to bacteria.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

Corrosion of Iron and Steel. By J. NEWTON FRIEND, Ph.D. Longmans Green & Co. 1911. Pp. 300; 62 figures.

Of the many references to the literature of the subject cited by the author, none is more interesting than the following from Pliny written some 2,000 years ago. In his "Natural History" Pliny writes "there is a kind of hallowing iron within the city called Zeugma, seated upon the Euphrates, where-with King Alexander the Great some time bound and strengthened the bridge over the river there; the links whereof, as many as have been repaired and made new since, do gather rust, whereas the rest of the first making be all free therefrom." Evidently at this very early date the observation had been made, not only that iron rusts, but that different pieces may rust at different rates. The general subject has received so much attention from men in widely differing fields, and their publications have appeared in so great a number of places, that there existed a need for a work which would thoroughly digest this literature and gather together that portion which seemed sufficiently reliable to be of service to the investigators of the present. This task, which has not been an easy one, Dr.

Friend has accomplished in a thoroughly satisfactory way in the present volume.

The action of air and water and also steam upon iron is discussed at length, together with the various theories which have been advanced to explain corrosion. The author's experiments to prove that a trace of carbonic acid, however minute, is essential in order that rusting will take place, are of but academic interest, since such conditions can never be duplicated except with the refinements of a laboratory; and his conclusion that the electrolytic theory of iron is untenable is not warranted. In fact, the so-called acid theory which the author vigorously defends is none other than the electrolytic theory, where the assumption is made that the hydrogen ion concentration in pure water is not great enough to produce a speed of reaction sufficiently high to make the rusting of iron at low temperatures obvious; while by the introduction of carbonic acid the concentration of the hydrogen ions is increased to such a point that iron will pass into solution rapidly enough to appear as rust. The book in many places suffers somewhat by the author's unwillingness to make use of the conceptions introduced by the electrolytic theory which, were they used, would simplify the treatment.

The chapters on the factors influencing the rate of corrosion exposed to natural forces, the action of acids and single salts and other electrolytes upon iron are most complete and give the reader a clear idea of the existing knowledge of this phase of the subject. Chapter XIII. is devoted to the passive state of iron, and while it seems to contain all that we know upon the subject it emphasizes the fact that our present knowledge is far from giving us a satisfactory explanation for this peculiar phenomenon. The later chapters deal comprehensively with the influence of chemical composition upon the durability of iron, electrical and galvanic action, and the relative rate of corrosion of iron and steel.

It is a matter of regret that the author has been misled, as have also the reviewer and others, by giving credence to statements and data supplied by the American Rolling Mill

Co., of Middletown, Ohio, which he publishes on pages 114, 250, 276 and 251, regarding the purity of this firm's products. For example, the material said to have the analysis published on page 114, as containing 99.954 per cent. iron, and which on page 276 is proposed as a standard for *pure iron* on which to base a corrosion factor, was later found by the author himself, much to his surprise, to contain .172 per cent. copper.

The book constitutes a distinct and valuable contribution to the literature on the subject of corrosion, and will prove of interest to the general reader as well as of great service to those particularly interested in this field.

WILLIAM H. WALKER

Principles of Electrical Engineering. By HAROLD PENDER, Professor of Theoretical and Applied Electricity in the Massachusetts Institute of Technology. New York, McGraw-Hill Book Company. 1911. Pp. xviii + 438.

Convinced that the principles of electrical engineering are the principles of physics—a fact too frequently overlooked—and recognizing that a clear conception of these principles is essential for a proper understanding of the complicated reactions that take place in electric machinery and transmission circuits, the author of this book in an admirable manner deals successively with the more important phenomena of electricity and magnetism, continuous and alternating currents. On the whole the treatment is satisfying and thorough. The mathematical discussions are adequate but, being merely a means to an end, are not too extensive. Descriptions of machinery and apparatus—even of the transformer—are entirely omitted, the book having the same relation to electrical engineering as a first-class treatise on mechanics has to mechanical engineering. There has long been a demand for a comprehensive and thorough treatise of this kind. It has been customary either to shirk the matter and use descriptive texts, or to use separate texts, on the elements of electricity and magnetism, electrostatics, alternating currents, etc.

Technical schools should make every endeavor to develop men who are capable of advancing the art and who are not mere followers of "best practise," an end that may be secured by the more general use of books of this type. The reviewer agrees thoroughly with the author's point of view and in general with his methods; minor criticisms seem unnecessary. The lack of reference to the work of others is noticed. The abbreviation of "logarithm" to *ln*, in the same font as is used for expressing quantities, seems undesirable; thus, *ln i* is not recognized at once as the familiar $\log i$. Some statements in regard to units might well be qualified by the insertion of "sometimes used" or of some similar phrase; since, for example, no electrical congress has recommended the "gilbert" or the "abvolt," objection may be taken to the statements that the C.G.S. unit of magnetic potential difference is the "gilbert" (p. 92) and the C.G.S. unit of electric potential difference is the "abvolt." In general, however, the phraseology is precise.

FREDERICK BEDELL

Electro-Analysis. By EDGAR F. SMITH, Professor of Chemistry and Provost, University of Pennsylvania. Fifth edition. Philadelphia, P. Blakiston's Son & Co. 1911. 12mo. 332 pages, 46 illustrations, flexible leather binding. Price ?

The revised and enlarged edition of this attractive and useful book contains, as new material, the essentials of all that has appeared upon electro-analysis during the past four years. The author particularly emphasizes his continued success in using the mercury cup and his conviction of its wide utility in electrolytic analysis. To those unfamiliar with the previous editions it may be said that the work contains practically everything of value extant in electro-analysis, presented in most attractive and available form, and that possibly half of the whole subject matter is the direct work of Dr. Smith and his students and assistants. It is quite pertinent to call attention to the fact that many of the methods of

exact quantitative separation and precipitation used in electro-analysis are borrowed from and constitute modifications of industrially applied processes; this is especially true of the mercury cathode methods; reciprocally it is even still more evident that many valuable industrial processes have evolved from the laboratory investigations and the exact manipulations of electro-analysis, and yet more are waiting to be developed. This reciprocal excitation of laboratory and works is a particularly gratifying object lesson in modern scientific and industrial interdependence. We therefore recommend the book most heartily, not only to chemical analysts, but just as strongly to technical electrochemists studying the problems of electrochemistry, both in the research laboratory and in the works.

JOSEPH W. RICHARDS

THE HABITS OF FLIES OF THE GENUS
CORDYLOBIA, PARASITIC ON MAN
IN AFRICA

In Africa the larvæ of certain flies (*Cordylobia*) of the family Muscidae are parasitic under the skin of man and other warm-blooded animals in the same manner as are the larvæ of many of the flies usually grouped together as *Cæstridæ*. Until recently the manner in which *Cordylobia* infected its host was unknown. Independent results have now thrown light on this question.

Monsieur E. Roubaud, in the *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences* of the 23d of October, 1911, presents the results of his studies of the "Ver du Cayer," *Cordylobia anthropophaga* Blanchard. The larva is found under the skin of man and domestic animals. In the *Cæstridæ*, with the forms found in tumors under the skin, two distinct modes of infection of the host are known. In both cases the eggs of the fly are laid upon the host. In one case the newly hatched larvæ penetrate at once to their proper habitat, but in the other the eggs are swallowed by the host and the newly hatched larvæ bury themselves in the tissues of the *œsophagus* and only reach the surface after protracted wanderings within the body of

their host. With these facts in mind M. Roubaud experimented upon *Cordylobia*. He found that eggs placed directly upon the skin do not result in the infection of the animals. In the same way his experiments indicated that where eggs were swallowed by animals no infection followed. His experiments with a third method proved successful. Fifteen small larvæ were taken immediately upon the hatching of the eggs and were placed upon a light layer of sand in a large vessel. A guinea pig was shut up in the vessel for twenty hours and then taken out and placed in a wire cage. The result was that three days afterwards six tumors were found on the under side of the body, upon the muzzle and near the anus, each one containing a rapidly developing larva. His experiments indicate, therefore, that infestation is accomplished exclusively by the direct and active penetration of young larvæ hatched elsewhere. He followed day by day the evolution of the larva and describes the successive stages, which occupy only a week. He believes that Europeans are only accidental hosts of this parasite, but that with the natives who sleep on the ground the infection is naturally much more easy. The investigations were made in the laboratory at Bamako.

Of equal interest are the observations of Herbert von Pelsler-Berensberg ("Societas entomologica," Vol. 26, p. 34, July 29, 1911) on *Cordylobia rodhaini* Gedoelst. It had been supposed that uncleanly habits led to infection, but it was found that those persons who bathed most frequently were most subject to infection and the inference was that the eggs were laid upon the exposed body. Keeping eggs under a watch-glass bound to his arm, von Pelsler-Berensberg found that the newly hatched larvæ, while they gnawed the skin, did not succeed in penetrating. Later he solved the problem by direct observation. While bathing he noticed that certain flies were attracted to the clothing which he had spread out on bushes, in the sun, to dry off the perspiration. He found that these flies were *Cordylobia* and that they had glued about twenty eggs to his underclothing. As an experiment he continued to wear the clothing.

Examination at the end of the first day showed that the eggs were intact, but on the second day they had hatched. Search with a lens upon the skin revealed some minute red spots and beneath these were the young larvæ, about .5 mm. long.

FREDERICK KNAB

THE NATIONAL ACADEMY OF SCIENCES

THE scientific program of the National Academy of Sciences, which met at Washington on April 16, 17 and 18, was as follows:

George E. Hale: "The New Tower Telescope of the Mount Wilson Solar Observatory."

W. W. Campbell: "Radial Velocities of 213 Brighter Class A Stars." "Radial Velocities of 190 Brighter Class F Stars." "Some Characteristics of Stellar Motions."

W. J. Humphreys (introduced by Cleveland Abbe): "Holes in the Air."

E. A. Harper: "The Organization of the Cell Colony in *Pediastrum*." (By title.)

D. H. Campbell: "On the Morphology and Systematic Position of *Calycularia radiolosa* (Sander Lac) Stephens." (By title.)

William Trelease: "A Revision of *Phoradendron*."

H. F. Osborn: "Biological Foundation of Bergson's 'Creative Evolution.'" (By title.)

E. S. Morse: "Biographical Memoir of C. O. Whitman." (By title.)

G. L. Goodale: "Biographical Memoir of Alexander Agassiz." (By title.)

By invitation of the Council—

Harvey Cushing: "Some Observations on the Functions of the Pituitary Body."

Jacques Loeb: "The Activation of the Animal Egg from the Physico-chemical Standpoint." (By title.)

J. A. Holmes: "The National Phases of the Mining Industry."

C. G. Abbot: "The Solar Radiation."

ANNUAL MEETING OF THE AMERICAN FEDERATION OF TEACHERS OF THE MATHEMATICAL AND THE NATURAL SCIENCES

THE American Federation of Teachers of the Mathematical and the Natural Sciences held its annual meeting at the New Willard Hotel in Washington on December 27.

The associations composing the federation reported concerning their activities during the past year, and the reports of committees were considered as follows:

Action on the recommendations in the report of the committee on college entrance requirements was postponed for one year, with the understanding that the various associations were to take action on it in the meantime, and were to report their decisions to the federation.

The national geometry committee report was approved as a report of progress. The chairman, Dr. Slaughter, reported that a preliminary report would soon be distributed to all members of the federation who were engaged in mathematics teaching, as well as to such other teachers as were interested. An edition of 5,000 copies will be published, the expense being borne by the National Educational Association.

The amendments reorganizing the council by limiting the representation of each association to one member were adopted, as follows:

Section 5. Each association shall have one delegate on the federation council, this delegate to cast one vote for every fifty members of the association he represents, but to have at least one vote. The delegate may be chosen in any way decided upon by his association, shall hold office for three years, or until the appointment of his successor, and shall be eligible for reelection. In case of a vacancy by death or resignation, the association in question must at once appoint a successor.

Section 7. The duty of a delegate shall be to keep the secretary of the federation informed as to the activities of his association, and to represent the interests of his association at every meeting of the council. If for any reason he can not attend a meeting, he shall be responsible for being represented by a properly accredited proxy.

The associations have been asked to appoint these representatives at once, and it is hoped that the new council will soon be in full working order.

The treasurer reported as follows:

EXPENDITURES

Stationery and stamps	\$ 8.50
Printing and mailing	70.52
National Geometry Committee	100.00
	<u>\$179.02</u>
Balance	85.78
	<u>\$264.80</u>

RECEIPTS

Balance from 1910	\$ 85.60
Dues from 12 associations	179.20
	<u>\$264.80</u>

One association, the Association of Biology Teachers of New York, has resigned from the federation, and two associations with an approximate membership of 150 have not yet paid their dues for the year.

A committee of teachers of physics, J. A. Randall, Pratt Institute, Brooklyn, chairman; W. R. Pyle, Morris High School, New York City; W. A. Hedrick, McKinley Manual Training School, Washington, D. C.; G. A. Works, Madison, Wisconsin; P. B. Woodworth, Lewis Institute, Chicago, has been appointed "to coordinate new apparatus and new teaching content with the present secondary school physics course."

Mr. Randall is chairman of a similar committee of the New York State Science Teachers' Association, and committees to cooperate in this work have already been appointed by the Physics Club of New York and the New Jersey State Science Teachers' Association. It is hoped that the National Educational Association will decide, at next summer's meeting, to be a partner in this undertaking, as it has been in the work of the National Geometry Committee.

The plan of work for the committee is to have each member act as chairman of a local committee, which shall investigate conditions in its territory, collecting data as to new apparatus and improvements in courses to be submitted to the general committee, and giving to the instrument makers plans for whatever apparatus seems worth while. The general committee will probably form a new definition of the "physics unit" to correspond with what they find to be the most improved usage in the subject, and will perfect machinery by which every physics teacher in the country can secure the most improved forms of equipment.

On Thursday morning, at a joint session with Section L of the American Association for the Advancement of Science, the members of the council listened to addresses by Professor C. W. Moore, of Harvard; Professor A. L. Jones, of Columbia, and Dean J. R. Angell, of Chicago University, on the new systems of admission to these colleges.

EUGENE R. SMITH,
Secretary

POLYTECHNIC PREPARATORY SCHOOL,
BROOKLYN

ANTHROPOLOGY AT THE WASHINGTON MEETING FOR 1911

THE annual meeting of the American Anthropological Association was held in the United States National Museum, Washington, D. C., December 27-30, 1911, in affiliation with Section H of the American Association for the Advancement of Science and the American Folk-Lore Society. The attendance was good and the program exceptionally long and interesting. The most important features were the two symposia: (1) "The Problems of the Unity or Plurality and the Probable Place of Origin of the American Aborigines," discussed by J. W. Fewkes, A. Hrdlička, W. H. Dall, J. W. Gidley, A. H. Clark, W. H. Holmes, Alice C. Fletcher, Walter Hough, Stansbury Hagar, A. F. Chamberlain and R. B. Dixon; and (2) "Culture and Environment," discussed by J. W. Fewkes, Clark Wissler, Edward Sapir and Robert H. Lowie. The first of these two discussions is printed in full in the January-March issue of the *Anthropologist*, and the second will appear in the April-June issue. Dr. J. Walter Fewkes presided at the six sessions in charge of the American Anthropological Association; also at the single session of the American Folk-Lore Society, in the absence of Professor Henry M. Belden, president of that society. Professor George T. Ladd, vice-president of Section H, was chairman of the single session in charge of the section. The social functions to which members of the affiliated societies were invited included: a reception by Dr. and Mrs. Robert S. Woodward at the Carnegie Institution, a reception at the New National Museum, and the opening of the Corcoran Gallery of Art.

SECTION H

Officers for the Washington meeting were nominated as follows: member of the council, Dr. Ales Hrdlička; member of the general committee, Dr. Charles Peabody. Sectional offices were filled by the nomination and election by the general committee, of Dr. J. Walter Fewkes, Bureau of American Ethnology, as vice-president for the ensuing year; Dr. Alfred M. Tozzer, member of the sectional committee to serve four years (to fill a vacancy), and Dr. Pliny E. Goddard, member of the sectional committee to serve five years.

President Fewkes opened the first public session of the joint meeting with the following remarks:

Ladies and Gentlemen, Members of the American Anthropological Association:

A year has passed since the last meeting of the association and we have now again gathered together, bringing from field and laboratory new material to lay before our fellow workers for their critical examination. It is eminently fitting that we should hold our service in this beautiful building erected by the nation to contain the precious collections gathered from the uttermost parts of the earth as well as our own country. Part of these collections illustrate the physical and cultural history of man, the sciences we cultivate. Our place of meeting should stimulate us with a new enthusiasm and a high ideal of research, and the time of year a new sense of the service to humanity it requires. Although our science has a very practical side, its strength lies primarily in the study of truth for its own sake and thereby the elevation of human character. With your assistance it shall be our effort to eliminate, as far as possible, all personal feeling in our discussions and keep continually in mind the noble ideal that all our work is a service to science.

It has seemed desirable to group our communications in such a way that discussions of methods and principles would be a prominent feature, and it is earnestly hoped that these discussions may be untrammelled by personal feeling, critical when necessary, but always on the highest possible plane. It is evident to all that with so many speakers, all of whom we desire to hear, it may be necessary sometimes for a speaker to curtail his remarks to conform to the time allowed by the committee. Although in such condensation he may feel that he can not do himself full justice, it is to be hoped that he will make the sacrifice for the sake of others who follow.

ADDRESSES AND PAPERS

The address of retiring Vice-president Roland B. Dixon of Section H on "The Independence of the Culture of the American Indian" is printed in *SCIENCE* of January 12, 1912.

In the absence of President Henry M. Belden, of the American Folk-Lore Society, his address on "Folk Poetry in America" was read by Dr. Charles Peabody.

Many of the important papers read at the joint meeting are represented in this report by abstracts. These are:

Investigations among the Plains Indians: CLARK WISSLER.

A preliminary statement of the general plan

for work by the American Museum of Natural History among the Northern Plains tribes and the southwestern Indians was presented in brief, followed by a general comparative résumé of the results in the Northern Plains. Attention was called to recent evidences for the former use of pottery by the Blackfoot Indians and its apparent similarity in type to that used by the Menominee and the Saulteaux. The chief discussion, however, was confined to ceremonial bundles of the Blackfoot, special attention being called to the great uniformity of structure in the rituals belonging to the same, suggesting that all had a common origin. Certain striking similarities to Pawnee rituals were pointed out as well as correspondence with the Cheyenne. It was noted, however, that the Blackfoot bundles seem to be of a distinct type as opposed to those of the Menominee, Winnebago, Osage, Sauk and Fox, etc. The individuality of the Blackfoot bundle scheme is shown in the peculiar transfer conception by which a bundle may pass from one person to another without restriction. There was also an investment feature in the transfer, that is, while considerable property changed hands when the bundle was secured, the owner could at any time secure an equivalent return by transferring the bundle to another. The transfer-investment character of Blackfoot rituals has not so far been reported among other tribes and may remain tentatively as a Blackfoot characteristic.

Problems in the Ethnology of the Crow and Village Indians: ROBERT H. LOWIE.

One problem in the ethnology of the Northwestern Plains is the extent of Caddoan influence. It is certain that one form of the pipe ceremony was introduced by the Arikara among the Hidatsa and thence traveled to the Crow. It is further possible that the origin of the earth lodge among the Hidatsa and Mandan is due to the same tribe, and accordingly it is necessary to study the Arikara-Pawnee culture in order to ascertain what other elements of the culture of the Upper Missouri may be reasonably traced to this source. A second problem suggested by a comparison of the Hidatsa and Crow is that of cultural differentiation among genetically affiliated tribes. The Crow and the Hidatsa are linguistically very closely related and must have separated in relatively recent times; nevertheless, the main features of their social and ceremonial life differ to such a degree that a purely cultural comparison could not satisfactorily establish a genetic relationship between them. A third problem is the

character and development of the "age" societies. It appears that certain features of these societies are widely diffused over the entire Plains area, while the system of age grades is confined to but five tribes. The essential factor in entering the age societies is purchase. An historico-critical investigation of the conceptions of these societies expressed in the writings of Maximilian, Schurtz and Kroeber is highly instructive as to the methods employed in ethnological thinking.

The Principle of Convergence in Ethnology: ROBERT H. LOWIE.

Dr. Graebner in his "Methode der Ethnologie" denies that the principle of independent development is logically on a par with that of historical connection in the explanation of resemblances. He also regards convergent evolution as involving assumptions as to a mystical psychological unity of mankind. Neither of these views is justified. More especially, the apparent mysticism in the doctrine of convergence disappears at once if the supposed identities are recognized not as ethnological realities, but as logical abstractions—not as homologies, but as analogies.

Notes on the Material Culture of the Rio Grande Pueblos: HERBERT J. SPINDEN.

The cultural conditions found in the southwest may be explained by divergent evolution due to a different economic use of the land. The aridity acted as a natural barrier against a people in the hunting stage, becoming one in the agricultural stage. The change could only be accomplished by cooperation in the building of irrigation ditches, etc., and by corresponding changes in the habits of life.

The nomadic tribes used the soil extensively. They gathered natural fruits and followed the chase. The sedentary tribes used the soil intensively. They irrigated the soil, built permanent villages and cultivated the household arts of weaving and pottery making. The minor features of material culture show the fundamental bond between the sedentary Indians of the southwest and the nomadic Indians of the Plains and Plateau. The following rough classification of the arts may be of interest.

Arts largely resulting from the change to sedentary life: architecture; pottery; weaving; decorative symbolism; use of white clay in cleaning buckskin; rattles of deer hoof, etc.; use of heart line in realistic art; occurrence of horned and plumed serpents in realistic art; use of sand paintings.

Features of extremely wide distribution not given in the above list: coiled basketry; bags or cloths of yucca fiber, Indian hemp, etc.; fire drills and pump drills; tubular pipes; grooved stone axes, arrowheads, etc.; flageolettes, flutes, drums, tambourines, etc.

Features that are probably of southern origin: metates; compound arrows with reed shafts; corn and other agricultural products; details in textiles and ceramics.

Features suggesting connections with the Plains and Plateau: buffalo shields and covers; war whistles; scalping knives; war lances and other regalia; deerskin shirts and leggings; porcupine quill decoration; decoration of buckskin by perforation; buffalo and elk hide blankets with decorated strip; rabbit-skin blankets; war-bonnets; sinew-backed and horn bows; double quiver with separate bow and arrow cases; grooved arrow rasps and polishers; flint flakes of bone; perforated arrow straighteners; self arrows with blood grooves and painted rings; wickerwork carrying baskets built on a foundation of two crossed sticks; fish trap made by converging walls and willow mat; mats of sewn tule; saddle made of two long narrow cushions; skin dressing tools; use of brains in tanning.

Some Aspects of the Negro Problem: ALBERT ERNEST JENKS, University of Minnesota.

Immigration.—Since we have a serious negro problem is it reasonable that this problem be made more difficult by admission into the United States each year of an increasing number of un-Americanized immigrant alien negroes?

There are no United States laws against such immigration. Just short of 40,000 such persons have come to this country in the last ten years; in 1911 we received 6,721. They come from near at hand—three fourths coming from the West Indies. The West Indies have nearly 6,000,000 negroes, any of whom may come to the United States. America debars oriental peoples, not because they are inferior, but because they and their culture are so different from American people and culture. For the same reason we should exclude the "African black." He should also be excluded because his admission is unfair to the white and also to the negro American—since he makes even more difficult one of America's most perplexing problems.

Miscegenation.—There are two forms of negro-white miscegenation: (1) Legal marriage, per-

mitted in twenty-three states where the unions are largely between negro men and white women; (2) illegal, more or less temporary unions, usually between white men and negro women. Investigation in a certain area shows that 65 per cent. of the white wives of negro men are foreign-born girls—usually of Teutonic peoples. Over two per cent. of children are born to these marriages. The result of both these forms of miscegenation is an increasing number of mulattoes cemented by color and prejudice to the negro race, while by inheritance they are endowed to a considerable degree with Anglo-Saxon initiative, will, ideals and desire for a square-deal—which, because of their color, they can seldom get. These mulattoes are the migrants in the north and west of the United States; they are more migrant than the restless, foot-free white American. The mulatto is the chief factor in the negro problem; the problem is bound to increase, then, in geographic area, in number of discontented negroes, and in its intensity, hand in hand with the increased flow of Anglo-Saxon blood into the veins of this new American man. All forms of miscegenation between the two races should be made a felony, punishable for one offence; and the father of children born to one white and one negro parent should be held to support and educate such children.

Who is a Negro?—The negro should be defined uniformly, so that there would be no question of the legal and racial status of any given person, no matter in what commonwealth he may be. To-day there is no such uniformity of laws.

Murderous Race Riots.—The white man's passion against the offending, or suspected, negro is often nothing short of blood vengeance against the negro race. This is seen in the fact that assault against the virtue of a white woman is only one of some three dozen offences for which negroes are annually lynched. In many of these lynchings and burnings murder is not committed in the frenzy of the moment; the mob starts out to lynch or burn—the crime is premeditated. If America is to train her annual armies of immigrant recruits into law-respecting and law-abiding citizens, she must punish to the limit necessary all participants in murderous race riots.

Education.—Each negro child should have, so far as public and private schools are concerned, an equal opportunity with the white child to make of himself all that he is capable of being.

Investigation.—A commission should be selected to study every aspect of the negro problem. This

commission might well be financed by private funds so as to keep it from the almost certain bias of politics and sectionalism.

Presentation of Specimens of Eolithio Form from Salinellas (Gard), France: CHARLES PEABODY.

Dr. Marignan (Hérault) recently discovered chipped flints, which he considers to be eoliths. In spite of their localization the specimens are eoliths in facies probably rather than in actual age. Noteworthy is a series of discoidal hammers. The natural fractures of the flint and the outlines of the stones were carefully noted and compared with specimens from the Kent Plateau, Boncelles, etc.

Cacimbas of the Isle of Pines (Cuba): J. WALTER FEWKES.

The word *cacimba*, varying in form, apparently found in several linguistic stocks, is widely spread in aboriginal Latin-America, from the Andes in South America to the larger Antilles. It is supposed by most linguists and by natives generally, to be a purely aboriginal term signifying a receptacle or, in a slightly changed form, possibly another word, a pipe. In the Isle of Pines it is applied to a hill with reservoir-like depressions, and to a landing place called "Embocadero de los Casimbas," near Sigüea Bay, but mainly to certain artificial subterranean, vase-shaped receptacles occurring in various localities. The *cacimbas* are always constructed under ground, where they are either cut out of the solid rock or built of rude masonry. In a few instances the lower portion is excavated and the upper or neck is formed of a wall of undressed stone.

About thirty of these structures were examined in various localities in the Isle of Pines, others being reported from the south coast of the western end of Cuba. They occur near to or far from the banks of rivers, some distance from the seashore, in woods or open fields, singly or in clusters. The largest number was found near Nueva Gerona and Santa Fé, the latter situated in the middle of the island, where considerable quantities of turpentine were once made, as indicated by remains of ovens of undoubted Spanish manufacture. Isle of Pines *cacimbas* are accompanied, especially where the surface of the ground has not been greatly disturbed, by low circular mounds depressed in the middle but with raised rims varying from twenty to thirty feet in diameter, situated about the same distance away and overgrown with guano prieta or black-bark palmettos and under-

brush. The *cacimbas* average about five feet in depth; four feet is the greatest diameter and the narrowed, neck-like entrance, the rim of which is sometimes elevated a foot above the surface, has an orifice large enough to admit the human body. Their inner surface is generally smooth, plastered and blackened, the mortar in which the stones are laid being black, as if impregnated with tar. The floor is flat, circular, sloping slightly to the center, where, in one instance, there is a groove connecting with a covered trench which opens on the hillside. A thin layer of tar was found covering the floors of several examples. When these *cacimbas* were cleaned out they were discovered to be about half full of rubbish, damp soil, debris and decaying leaves. No aboriginal implements or human bones occur in any of them, but there were in one a few fragments of Spanish pottery and the broken jaw of a domestic hog, with other animal skeletal remains. The moist earth in some *cacimbas* is a favorite habitation for the Cuban crayfish, many specimens of which were taken from one of these structures near Mr. Allnutt's home a short distance from Nueva Gerona. Trenches dug diametrically across the adjacent mounds revealed black layers containing ashes and charcoal with fragments of tar just below the humus, but no walls or aboriginal objects were observed in these mounds.

The Isle of Pines *cacimbas* are almost universally, and without hesitation, ascribed by the natives to the Indians. It is sometimes held that they were constructed by Caribs as storage places for tar and other objects, as their name implies, and one intelligent person affirmed that the builders were Indians working under Spanish direction. It is claimed by others that they were made by white men and were used as receptacles for turpentine, the neighboring mounds being the places where this substance was manufactured. One of those who held this opinion claimed that pine logs were so laid on the mound that their ends were brought to the center and application of heat caused tar to ooze from them into a pan or small receptacle, from which it was transferred to the *cacimba*. No reliable facts that would prove or disprove any of the current theories were obtainable, but it is certainly strange, if these structures are of Indian manufacture, that no aboriginal objects or implements were ever found with them. Under the circumstances their origin remains one of the unsolved problems of the West Indian culture history. However, the opinion of a very intelligent native of advanced years, who claimed

that he was a descendant of one of the Comareo Indians of the Isle of Pines, is worthy of record. He said that he had been told by his father, who came from Camaguey, that they were constructed by the Indians and that he had never heard that white men made them or used them as turpentine receptacles. Two cacimbas, situated about three miles from Nueva Gerona where the road to El Bobo forks, sending a branch to McKinley, are called Cueva de los Indios, although there is no cave in the vicinity.

The morphological resemblance of the cacimbas to the chultunes of Guatemala and Yucatan is great. Cacimbas are ordinarily smaller and differ from chultunes in not containing aboriginal objects. If the structures are Indian and pre-Columbian, of which I confess doubts, this unique fact is significant as being the only resemblance thus far found in the antiquities of western Cuba and the neighboring peninsula of Yucatan. No evidence can be presented to indicate that they are related to the cave men of Cuba or to those Indians whose skeletal remains were found in the Cueva de los Indios near Nueva Gerona.

The Chultunes of Northern Guatemala: ALFRED M. TOZZER.

The subterranean cistern-like reservoirs called "chultunes" of northern Yucatan as described by Mr. E. H. Thompson in his paper on "The Chultunes of Labna" seem to have been intended primarily for the storage of water. They are found in most cases in regions where there are no natural sink-holes or cenotes or other available source of water. In a few cases they may have been used as burial places.

In northern Guatemala the country is well watered and there is little need of cisterns for the storage of rain-water. The chultunes, however, are far more frequent than in the peninsula to the north. A large number were mapped along the route taken by the Peabody Museum Expedition of 1909-1910. They seem to stretch in long lines connecting the various ruined centers in this region. In addition, several were found in close proximity to the cities themselves.

The chultunes of this region are of two types, the simple cistern-like subterranean chamber similar to those in the north and the lateral-chambered chultun. This second type is met with far more frequently than the first and consists of a room excavated out of the rock and opening from the bottom of the shaft.

From the fact that these chultunes occur in

many places where there is an abundant supply of water, it may be argued that the storage of water is not the primary object of these subterranean rooms. Some were no doubt used as burial places. From a large lateral-chambered chultun at Yaloch a large collection of excellent Maya pottery has been taken out. From the manner of occurrence it seems probable that there was a burial here on the floor of the chamber, although no bones of any kind were found still existing in the three feet of earth which had been deposited in the chamber. Three examples of a tall bottomless type of vase were found which are unique. Covers to jars were also common.

Chultunes were also excavated at Chorro, Nakum and Holmul. From the large number of extensive groups of ruins in this area and the hundreds of small mounds and chultunes connecting these centers with one another, together with the examples of pottery from this region, it may be seen that here in northern Guatemala we have perhaps the most important center of the Maya culture.

The Mexican Maize Season in the Codex Fejérváry-Mayer: STANSBURY HAGAR.

On sheets 33 and 34 of the Codex Fejérváry-Mayer (Loubat edition) are two series of symbols including four paintings on each page, two above, two below. The four upper symbols, reading from right to left in the usual manner, picture the maturing of the maize crop during a period of four months: the lower symbols represent the deities governing the months mentioned. But the writer has presented evidence in a previous paper upon the "Elements of the Maya and Mexican Zodiacs"¹ that this sequence of deities also represents the zodiacal signs Cancer, Leo, Virgo and Libra. These signs correspond with the months July, August, September, October, which correctly represent the maize season described upon the Mexican plateau.

A Study of Biological Paleogeography in its Bearing on the Origin of Man in America: AUSTIN H. CLARK.

From a study of the geographical distribution of animals we find indicated: (1) an Indian Ocean land extending from the Lesser Sunda Islands (Sumbava to Timor) to Ceylon, Madagascar, the Mascarene Islands and southeastern Africa; (2) an Afro-Antillean land extending from the Mascarene Islands and Madagascar across south cen-

¹Sixteenth Int. Cong. of Americanists, pp. 277 et seq.

tral Africa to the West Indies and the highlands of South and Central America (including the Galapagos Islands); (3) a South Sea Island land bounded by Formosa (Taiwan), southern Japan, the Hawaiian and Marquesas Islands, New Zealand, New Caledonia and the Lesser Sunda Islands (but not New Guinea), possibly including Java, Sumatra, Borneo, Celebes, the Philippine Islands, and the Malayan region; (4) a large Australian continent including Australia, New Guinea and the Aru Islands (but not the Ki Islands nor the islands further west or north); (5) a connection between southern Australia and the Magellanic region; and (6) a very broad strait including the entire Behring Sea and the adjacent Arctic Ocean as far at least as Wrangel Island and the New Siberian Islands. 1 and 2 became disintegrated and disappeared at a very early date, probably long before the existence of man; 3 became submerged, first on the eastern border, very early, also probably before the existence of man; 5 disappeared very early, but persisted late enough so that much of the southern South American fauna entered that continent from Australia by means of it; it is possible that man also entered South America along this path and later entirely lost his Australian character through amalgamation with the true American stock from the north; this would account for certain Australian characteristics found among the Fuegians; 6 persisted long after man inhabited eastern Asia; it was thus probably the path by which man entered America.

The People of Sandao-a: ELIZABETH H. METCALF.

In the extreme southern part of Mindanao, the most southern and largest of the Philippine Islands, on the foothills of the beautiful volcano which the Spaniards call "Apo" (The Grandfather), live the Bagobos, a pagan tribe of high mentality, docile natures, spectacular in dress, and in some respects very primitive. They call the volcano "Sandao-a" (pronounced Sandowa), "The Sulphurous One." These Bagobos are a mountain people, and to a certain extent nomadic. They understand only the cultivation of mountain rice; and as this necessitates the cutting of a new bit of forest each year for their rice plantation, they are likely to move also each year into the vicinity of the new rice field. Recently they have been brought together into villages by government order. Although the American arrangement of the tribal wards somewhat curtails the political power of the present head Dato, he is still highly esteemed by both natives and Americans.

Formerly the wealth of the people was in slaves, animals, aguns and fine clothes. The days of slavery are past; the aguns, or big gongs, they still possess. These are their most important musical instruments; and the magnificence of tone coloring of many large gongs played together is quite indescribable. The Bagobos have other instruments of percussion, wind and strings, but these large gongs are also for them their medium of exchange, and a man's wealth is usually reckoned by the number of gongs he possesses.

Their clothes are made from hemp fiber, which the people weave into a cloth, unique in manufacture, and which lends itself admirably to the artistic fashion of ornamentation employed by these people. Of the old embroidery of cross-stitch on coarse Chinese cotton cloth, which the women understood fifty or more years ago, there are still a few samples to be found; but the present style of ornamentation consists of an applique in various forms of bright-colored cloth, of embroidery, of beads and tiny pearl disks sewn on in designs. The beads the people purchase from the Chinese merchants, the pearl disks are made from shells, found farther back in the mountains by another tribe living there.

The houses are always built up from the ground—sometimes of bamboo prepared in various ways, sometimes with the frame of wood with the leaves of certain trees laid on thickly for the roof and more openly for the sides. The entrance to the house is by a notched stick or by a ladder, and the furniture is exceedingly simple. A peculiar feature, especially of the houses of the aristocrats, is the different floor levels. At the extreme end of the house, opposite the door, the floor is often raised from 6 inches to 3 feet and the whole width of the house. This place is for guests and for the heads of the family. I have seen a house of an important old Dato with three floor levels; on the highest level only the old Dato and his wife and such persons as they might bid, could come.

The fireplace is usually near the door, with bamboo tubes of water standing on end nearby; the better class have bamboo frames of various kinds for holding dishes, and always in its proper place in every house, even the poorest, is the "Tambara," the little bowl containing the usual offerings, the simplest form of house altar. The greatest of their altars, the "Pat-a-non," or war altar, is also a house altar. The erection of this altar is allowed to only a very few high Datos and is connected with their most important fes-

tival, which occurs some time during rice planting. The most significant ceremonies formerly attended this festival, which might last from two days to two weeks; but as in other regions of the earth, so here, the incoming of commerce and civilization kills the ancient culture; and it is probable that if it is given at all in its entirety, it is only in the remote regions of the mountains, that this great festival of the "Ginun" is now observed with all its elaborate ceremonies. The Bagobos have other altars for different places and different occasions; altars for the planting of their corn or rice; for the cutting of their crops; and very often they place an altar with their offerings near a great tree or a beautiful spring or running water, especially if the water is to be used for any ceremony of purification.

A Note on the Personification of Fatigue among the Nez Percé, Kutenai, et al.: ALEXANDER F. CHAMBERLAIN.

In common with other authorities, Dr. Paul Ehrenreich, in his recent volume, "Allgemeine Mythologie" (Leipzig, 1910), takes the view (p. 159) that personifications of abstract ideas, etc., are of little mythological significance, being almost entirely of cultural or ceremonial import. Such personifications as do exist he regards as not primarily personifications of such qualities, but originally representations of lunar personalities, as, *e. g.*, in the cases of the Greek Hermes-Autolykos (gambling and pleasure) and the gambling-deities of certain North American Indians. According to Ehrenreich, the hunting-gods are "not really personifications of the hunt, but almost always the moon-god, or at least a being furnished with lunar traits" (p. 160). But this is going too far in the way of panlunarism.

Among interesting personifications of abstract qualities among the North American Indians are *sleep* among the Ojibwa (Schoolcraft) and *hunger* among the Shushwap (Teit). Another case is that of *fatigue* among the Nez Percé and the Kutenai.

As Bartels ("Medicin d. Naturv.," Leipzig, 1893) notes (p. 235), citing Bancroft ("Native Races," Vol. I, p. 284), among the Nez Percé there was a ceremonial participated in annually by all the males of the tribe between the ages of 18 and 40. The ceremonial, which lasted for from 3 to 5 days, had, as its most noticeable element the pushing of willow-rods down the throat into the stomach, this being followed by hot and cold baths and fasting. The firm opinion of the Indians is that they thereby obtain great bodily

strength and power of resistance to fatigue. The ceremonial is held in order to overcome *Mawish*, the spirit of fatigue. This is the Nez Percé "spring-medicine," reported on recently by Dr. Spinden. There are certain identities and resemblances in Kutenai and Nez Percé mythology, etc., that deserve careful study (one curious item is the presence in each of a character with *one leg*). *Mawish*, of course, is the Chinook jargon word for animal (*e. g.*, deer)—and the deer figures prominently in the dances, etc., of the Kutenai.

Initial and Terminal Formulae of Kutenai Tales:
ALEXANDER F. CHAMBERLAIN.

Although, in the adverb *pik'aks*, the Kutenai language has a word corresponding to our "long ago," "once upon a time," etc., so familiar as an initial formula in the tales and legends of many lands, this term does not appear as the customary beginning of such stories as have been recorded in the native text.

In narration the Kutenai employs the "historic present," as the grammarians term it, adding thus to the vividness of the story told. The great majority of the tales begin with a verb in the present tense, therefore, not with such a phrase as our "once upon a time," with its verb in the past tense. Examples of Kutenai initial formulae are:

Kānaquē Skinkuts	= Coyote is traveling.
Kānaquē tlántlā	= Grizzly-Bear is traveling.
Kāusākā'ne Wōtak	= Frog is there.
Kōnitlāinē Skinkūts	= Coyote is in his house.
Kōnitlāinē G'ōtsāts	= Chipmunk is in his house.
Tsināqē Skinkūts	= Coyote sets out (starts off).
Kāktlūnām'nē	= There is a village.
Nātlqōnē Djāis	= He carries his brother on his back.

Very seldom is the order as above indicated inverted, as *e. g.*, Mitsākās Kāusāk'ā'nē, "The Tomtit is there." The "Tale of Seven-Heads" begins: Wistātłātām sāhānē, "Seven-Heads is bad"; a tale of the owl, Kūpi tsākētlāine, "The Owl is a great thief." The term āswātlne, "together," begins a tale, as, *e. g.*, Āsmātlne tsināqē Skinkūts āqki Nāik'yū, "Coyote and Fox set out together," although the formula Skinkūts āsmātlne, etc., is also used. Among the Kutenai, as with some other Indian tribes of the Oregon-Columbian region, the coyote who figures so largely in myth and legend is represented as being "on his travels"; so, too, with certain of the other animal characters. Kānāque Skinkūts is the typical be-

ginning of most of the stories in which he plays the chief rôle; tsinâqê, "he starts off," "he sets out," is another initial formula of frequent occurrence in the animal-tales. The word Kâusâk'ainê signifies "he is at," "he stays," "he stops," "he is there," "he is." Such beginnings are Kônitlâine, "he is in his house," "he is at home," and Kâktlînâm'nê, "there is a village," are quite picturesque. Often there is no terminal formula in Kutenai stories. A common term, however, is .tâqas, "ended," "enough," "done," "finished." The phrase tlâtłlônê, "there is no more," also occurs. The terminal Kâpêt, used by some of the Indians, seems to be the Kôpêt of the Chinook Jargon, modified by supposed derivation from Kutenai K'âpê, "all."

The Allentiacan Linguistic Stock: ALEXANDER F. CHAMBERLAIN.

All the evidence in hand indicates that the language (extinct in the eighteenth century; represented by the "Grammar and Vocabulary" of de Valdivia, published in 1607 and 1608, reprinted in 1894 by Medina) of the *Allentiacs* or Huarpes forms an independent linguistic stock, the *Allentiacan*, as it may be called. The *Allentiacs*, according to Boman, were quite a savage people and unrelated to the tribes of the Andean valleys. This Argentinian people inhabited, at the time of the Spanish conquest, the plains about the great lagunes of Huanacache, extending probably to the western slopes of the Sierra de Cordoba, and southward to the northern parts of San Luis and Mendoza. The *Allentiac* linguistic material has been discussed by de la Grasserie (1900) and Mitre (1894 and 1909).

The Bororoan Linguistic Stock: ALEXANDER F. CHAMBERLAIN.

There can be no doubt of the status of the language of the Bororó Indians of Central Matto Grosso (Brazil) as an independent stock, as suggested by von den Steinen as early as 1886, or a little before that. Brinton in his "American Race" (1891) failed to recognize this, or had not noticed von den Steinen's statement, and classed them incorrectly as Tupian. It was only in 1888, as a result of the second Xingú expedition, that the identity of the so-called "Coroados" branch of the stock with the genuine old Bororo was established. Conflicts with the whites have sadly reduced the numbers of the Bororó. Their characteristic area, as defined by Frič (1906), is "the entire course of the S. Lourenço river as far as its

union with the Cuyabá, where they come into contact with the Guató." Further north they occupy "both banks of the Araguaya right across the road that leads from Cuyabá to Goyaz." In the first half of the eighteenth century these Indians roved about the region of the Xingú-Araguay watershed in central Matto Grosso. Later on, the so-called "Borroró do Cabaçal" settled on the upper Paraguay. The vocabulary of 360 words, given by von den Steinen, in his "Unter den Naturvölkern Zentral-Brasiens" (1894) is the most useful linguistic material of the Bororoan stock. Other vocabularies are given by Caldas (1899) and Frič and Radin (1906)—the last print also a vocabulary from Boggiani.

The Calchaquian Linguistic Stock: ALEXANDER F. CHAMBERLAIN.

The character of the Calchaquian language and the extent of the area over which it prevailed have been the subject of much discussion and dispute. Some have held that the Calchaqui, Catamareño, or Cacana tongue was nothing more nor less than a dialect or *patois* of Onchua, spoken in Tucuman, etc. Others seek to connect it with Aymara, Atacameñan, etc. The Calchaquis may have been a mixed people, as Lafone-Quevedo and Ehrenreich maintain. But there was an essential Calchaquian (or Diaguitan, as Boman prefers to call it) culture, and with it went a language, which was still spoken in the seventeenth century, and, from all appearances, seems to have been an independent form of speech, deserving rank as a linguistic stock. Boman (1908) failed to find any trace of the existence in Paris of the grammar and vocabulary of Calchaqui said to have been written by the Jesuit missionary Alonso de Barzuna (or Barcena) in the sixteenth century. The Calchaquian linguistic data consist of place-names, etc., discussed, *e. g.*, by Lafone-Quevedo, in his "Tesoro de Catamarquenismos" (1898). At its greatest extent the Calchaquian (rather than Catamarcan or Diaguitan) stock may be said to have occupied a territory of varying breadth, between about 23° 30' and 32° 30' S. lat. For the archeology of this region much knowledge is due to the researches of Ambrosetti, his colleagues and students.

Recent Opinion as to the Position of the American Indians among the Races of Man: ALEXANDER F. CHAMBERLAIN.

The author discussed briefly the various theories in the light of the scientific literature of the past

few years—the autochthonous, the European, the Asiatic. The protagonist of the theory of the autochthonous origin of American man is Professor Ameghino, the Argentinian paleontologist, who derives him from the higher simians in southern South America. Professor G. Sergi, the Italian anthropologist, who looks with some favor on Ameghino's views, recognizes—he takes a rather polygenetic view of human origins—among his separate human races a *facies Americana*. The old view of Boyd Dawkins (resurrected by him, in a somewhat modified form) that the Eskimo are the representatives or the descendants of European cave-man still finds favor in certain quarters, but the recognition of the interior origin (in the region east of Hudson Bay) of the Eskimo as demonstrated by Boas, etc., places this theory rather out of court. That the American race is simply a Mongolian type, a view once much in favor, has lost its standing since the results of the Jesup North Pacific Expedition have become known. The data acquired concerning the so-called "paleo-Asiatic" peoples (Chukchee, Konaks, Kamchadales, Yukaghir, etc.) of northeastern Asia and the peoples of northwestern North America, demonstrate that the "paleo-Asiatic" people, at least (as the Asiatic Eskimo did later) must have crossed from America to Asia long subsequent to the arrival of the ancestors of the American race from Asia (if they came by way of Bering's Straits, as now seems reasonable). The American Indians may thus be considered as an Asiatic people (sprung from the proto-Mongolian stock), considerably modified by their New World environment. By a reflux wave of migration they have "Americanized," as it were, a large section of northeastern Asia.

The Mourning Ceremony of the Southern Paiutes:
EDWARD SAPIR.

The main ceremony of the southern Paiutes of Utah, Arizona and Nevada is an annual mourning ceremony or "cry." The expenses of such a ceremony, which generally lasts for five days in June or July, are borne by two men, one of them a close relative of a recently deceased member of the tribe. Sometimes neighboring bands are invited to take part in the ceremony. The place of the mourning ceremony varies from year to year and is decided upon at a preliminary council meeting. The essential elements of the ceremony

are the singing of numerous mourning songs and the offering of valuables, such as baskets, articles of clothing and horses, in memory of the dead.

The songs, which are accompanied by rattles held by each singer, are to be classified into four sharply distinguished types, roan songs, bird songs, coyote songs, and mountain sheep songs. Each of these has its characteristic type of melody and accompanying movements on the part of the singers. There does not seem to be any idea of a grouping of the participants of the ceremony into four societies singing these different types of songs; one may join in the singing of any class of songs and leave one group of singers for another. There is, however, a song leader for each type of song. This merely means that certain people are proficient in the singing or composing of particular classes of songs. The texts of the songs are in comparatively few instances in Paiute, but belong to a language that is unintelligible to the singers. There is reason to believe that the types of songs, the actual song-texts, and perhaps the whole ceremony are borrowed from the Yuman tribes to the west. There is a possibility that the song texts consist of an elaborate system of burdens.

At various stages during the singing, which forms the major part of the ceremony, ceremonial "cries" take place which are conducted by a cry leader. On the last night of the mourning ceremony, during which it is forbidden to sleep, the articles which have been set aside as offerings to the dead are burned on a funeral pile; horses are shot, valuable articles which have been exposed as offerings may be taken by others and replaced by objects of less value. It is evident that the Paiute mourning ceremony bears considerable resemblance to mourning ceremonies of various Californian tribes.

Cephalic Type Contours: WILLIAM C. FARABEE.

The main object aimed at in all physical measurements is to find characters that shall be peculiar to the race or group of people under investigation. Under the old methods little attention was given to actual measurements of characters, except in so far as they aided in the determination of ratios or indices. The various indices for each individual were calculated and the average and range determined for the whole group. It was believed that these ratios were more constant than were the absolute dimensions and hence general conclusions were based upon the ratios obtained from short series.

Recently, improved methods have shown that these ratios have as wide range of variability as the measurements themselves and it has been found necessary to apply rigid statistical methods to the actual dimensions. The most constant characters of a large number of individuals must be observed and selected for measurement. In the past the head measurements have been considered of most importance and most constant. For the Harvard Expedition to South America De Milhau devised a cephalometer which allowed one to take measurements from the center of the auricular passage to any desired position on the head or face. For comparative group studies these dimensions were most satisfactory. Yet one very important factor was lacking, viz., the angle between the lines, which prevented any possibility of graphic presentation. To overcome this defect and to minimize as far as possible the importance of definitely locating all the positions mentioned, a protractor was attached to record these angles. This made it possible to locate the points to which the measurements were made, whether or not the positions were correctly determined. All measurements and angles were taken with reference to the horizontal plane of the Frankfort agreement. The vertical height is perpendicular to this plane and this line is marked zero in the scale.

When all results have been worked out according to correct statistical methods it will be possible to plot the *means* of all angles and measurements and when the ends of these lines have been connected by means of a spline a *type contour* will result. In the same way type contours of different related or unrelated groups in races may be made. These contours should be plotted on thin paper and superposed for comparative study. The advantage of the method is that it may be applied to the cranium as well as to the living head and direct comparisons made to determine relationships. Head measurements may be reduced to cranium measurements by allowing for the thickness of the cranial tissues.

Some Factors in the Differentiation of Human Types: ROBERT BENNETT BEAN.

Dr. Bean has studied random samples from four groups of mankind, Europeans, Africans, East Indians and Filipinos, and in each group three types that are similar in physical characteristics may be segregated. He has heretofore called these three types Primitive, Australoid and Iberian, but here they will be designated *A*, *B* and *C*, respectively.

Type *A* is small, brachycephalic and platyrrhine.

Type *C* is tall, dolichocephalic and leptorrhine.

Type *B* is medium in stature, mesocephalic or mesaticephalic and platyrrhine.

From the standpoint of growth other factors may be utilized to differentiate the types. It is known that the relative total leg and arm length increase from birth to maturity, the face increases in size, and the umbilicus descends. To make these factors relative we may use the length of the leg in relation to stature, the length of the arm in relation to stature, the size of the face in relation to the size of the head and the position of the umbilicus in relation to the position of the suprasternal notch and the symphysis pubis. Dividing the length plus breadth of the face by the length plus breadth of the head gives a cranio-facial index, which is low at birth and high at maturity. Dividing the distance of the umbilicus from the symphysis pubis by the distance of the umbilicus from the suprasternal notch gives the omphalic index, which is high at birth and low at maturity.

The three types may be assembled by the use of these factors according to the stage of development that each represents, as follows:

Type <i>A</i>	Type <i>C</i>	Type <i>B</i>
Hypo-onto-morph	Meso-onto-morph	Hyper-onto-morph
	Relative total arm length	
Small	intermediate	large
	Relative total leg length	
Small	intermediate	large
	Cranio-facial index	
Small	intermediate	large
	Omphalic index	
Large	small	?

Type *A* is less developed than type *B*, and type *C* is intermediate.

Additional factors, mainly descriptive, have been utilized to differentiate the three types, the form of the external ear or pinna enabling one to classify any individual after close scrutiny. The distinctive differences of ear form refer particularly to the inversion or eversion of the outer rim of the concha, and the rolling in (forward) or rolling out (backward) of the helix. These changes are especially to be seen at the lower part of the ear in the region of the tragus and antitragus, and the helix and antihelix. The ear of type *A* has an inverted concha—the tragus and antitragus appear to be pushed in—and an inrolled helix, giving it a trumpet or bell shape. The ear

of type *C* is the reverse of this: the concha is everted—the tragus and antitragus appear to be pulled out—and the helix is rolled back at its lower part. The ear of type *B* appears to be intermediate between these extremes. The ear type is more distinctive than any other factor, and may be utilized more readily, therefore it is more serviceable.

The nose form is useful in the differentiation of type, although it is not so good as the ear form. The nose of type *A* is infantile. The bridge and root are wide and depressed, the nostrils flare and open forward rather than downward. The nose of type *B* is wide, long and high, with depressed root, straight, high bridge and nostrils that are wide and open only slightly forward and downward. The nose of type *C* is narrow, long and high with high root and bridge and nostrils that open downward.

The soundness of the teeth in types *A* and *B* is noteworthy, whereas the teeth of type *C* are very unsound.

Type *C* is more susceptible to diseases of the epithelial tissues, or those organs derived from the primary epithelium, such as the alimentary canal and the central nervous system; whereas types *A* and *B* are more susceptible to diseases of the mesothelial tissues or the organs derived from the primary mesoderm, such as the circulatory system.

Types *A* and *B* seem to be linked together in many respects, and in this they are different from type *C*, which seems a more clearly differentiated type than the other two. The three types differ slightly in the different groups of mankind, and resemble the type that is distinctive for each group. For instance, type *A* is distinctive for the Filipinos included in the present study, therefore types *B* and *C* resemble type *A* among the Filipinos; type *B* is distinctive for the Africans, therefore types *A* and *C* resemble type *B* among the Africans; and type *C* is distinctive for the Europeans and East Indians, therefore types *A* and *B* resemble type *C* among these peoples.

Type *C* apparently retains its characteristics in all the groups more specifically than do the other types. As this type is so distinct in at least the four groups thus far studied, besides forming such a considerable part of these four groups, Dr. Bean concludes that this type in the four groups originated from the same stock. He therefore believes that the tall long-headed blond northern European, the small long-headed brunette southern European, the tall long-headed, straight-haired black East

Indian and the tall long-headed, kinky-haired African are derived from this original stock. Their ear form is identical, and other factors confirm this evidence. Existing differences may be accounted for by hereditary, climatic and cultural conditions.

Linguistic Classification of Algonquian Tribes:
TRUMAN MICHELSON.

Algonquian tribes linguistically fall into four major groups, to wit, Blackfoot, Cheyenne, Arapaho and Central-Eastern. The last may be subdivided into Central and Eastern. Of the Central subdivision, Ojibwa, Ottawa, Potawatomi and Algonquin form a special branch; and Peoria, etc., distinctly belong with them, but the latter are further removed from the others than any one of those from each other; moreover Peoria, etc., in certain respects are more archaic in their phonetics, and in some grammatical categories have more northern affinities. Menominee has the closest relations with Cree-Montagnais, though also is intimately connected with Fox, etc. Fox, Sauk and Kickapoo vary from each other but slightly; the differences are mainly in intonation and idiom. The first two are more nearly related than either is to Kickapoo. The last is closer to Fox than to Sauk. The three distinctly belong with Cree-Montagnais and Menominee as opposed to Ojibwa, etc. Shawnee is very close to Fox, Sauk and Kickapoo, but in certain respects agrees with Ojibwa, etc., and in others the Eastern subdivision. Natick clearly belongs with the Central and not the Eastern subdivision. In some categories it has affinities with the Ojibwa branch, but in others it is varied; and has some marked characteristics of its own. Delaware decidedly belongs to the Central and not the Eastern subdivision despite the popular notion to the contrary. The material in Zeisberger is a medley of Unami, Unalachtigo, Munsee. It is sufficiently clear that the linguistic relations of these were different; but the existing material is so unsatisfactory that it is premature to make any definite statement. The Eastern subdivision consists (to-day) of Micmac, Passamaquoddy, Malecite, Penobscot, Abenaki. Micmac is specialized in that it employs a conjunctive instead of independent mode; but the popular notion that it differs widely from the other members of the subdivision is mistaken, as is the belief that the Eastern subdivision belongs with Delaware. On the contrary the relations of the group are distinctly with Fox, etc., and Shawnee.

Dr. Michelson's paper is to appear in amplified form as one of the "Accompanying Papers" in an "Annual Report of the Bureau of American Ethnology."

The Status and Development of Canadian Archeology: HARLAN I. SMITH.

The archeological work of the Geological Survey since June 15, 1911, the date of Mr. Smith's appointment as dominion archeologist, has been divided into two main groups—the activities for diffusing archeological knowledge by such means as museum exhibits, guide books and lectures, and those for increasing such knowledge by exploration, original research and systematization.

The national collections have been classified tentatively into groups corresponding to the five ethnological culture areas. This grouping may be modified with the progress of research. The collection from the southern coast of British Columbia and the one from the southern interior of British Columbia are representative, and the collection from Ontario is large. The other provinces of the Eastern Woodlands, the Plains and the Arctic are hardly represented at all, and there are practically no data at hand concerning them. Popular guides have been prepared for the two western archeological areas, and work is progressing upon similar guides for the others. A series of lantern slides illustrating the archeology of Ontario has been made; general and topical labels for the collection are in the hands of the printer; duplicates of these will probably be furnished to the other museums throughout Canada, which with duplicate specimens, casts and photographs, when supplied to these museums, will make the archeological work truly national.

An archeological survey of the dominion is being organized, a reconnaissance has been made of some of the village sites in Ontario, and a survey of Brantford Township has been completed by Mr. W. J. Wintemberg. A scheme for systematizing and digesting the scattered and incomplete archeological data at hand and to be received in the future has been inaugurated. The cooperation of railroad officials, the northwest mounted police, Indian agents and geological explorers has been secured.

It is proposed to explore the less well known parts of Canada, beginning with intensive exploration at one site in each of the great cultural areas, in order that the results in the way of collections and monographs may be used as standards to which to refer for identification the results of

future exploration obtained in bordering areas where we may expect to find mixed or superimposed cultural material.

It is planned in the near future to make a reconnaissance of the Plains from which there is practically no material to-day available, to continue scientific exploration into the northern interior of British Columbia, using the Grand Trunk Pacific as a base, and to do an intensive piece of excavation along the St. Lawrence. Next the shell-heaps of the Atlantic coast may be examined.

The papers read of which the secretary was unable to obtain abstracts were:

The Anthropology of the Pueblos: A. HEDLIČKA.

To appear as a bulletin of the Bureau of American Ethnology.

Notes on the Words and Music of the "White Captive" Ballad: CHARLES PEABODY.

A Comparative Sketch of the Menominee: ALANSON SKINNER.

Quechua Folk-Music: W. C. FARABEE.

The Analysis of Chippewa Music: FRANCES DENS-MORE.

The Permanent Protection of the American Indian: FRANKLIN W. HOOPER.

Notes on the Chippewyan, Sarcee and Kiowa Apache: PLINY E. GODDARD.

Amalgamation in Minneapolis: A. E. JENKS.

Results of Field-work among the Hurons of Lorette (Quebec), Anderson (Ontario) and Wyandotte (Oklahoma): C. M. BARBEAU. To be printed in full in one of the annual reports of the Geological Survey of Canada.

The following papers were read by title:

William Carter, Bensontown Homer: PHILLIPS BAREY.

An Early Cranium of Homo sapiens from a Cavern at Unterlessee, near Trieste: HARRIS H. WILDER.

The Distribution of the Spear-thrower in South America: M. H. SAVILLE.

Some Analogies between the Pottery of the Southwest and that of the Predynastic Period in Egypt: A. V. KIDDER.

Early History of the Yuchi Indians: JOHN R. SWANTON.

The Relation of the Quickness of Learning to Retentiveness: D. O. LYON.

Cayuga Notes: GRACE E. TAFT.

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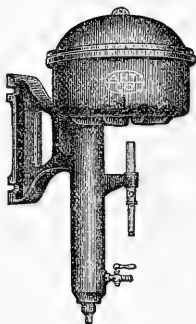
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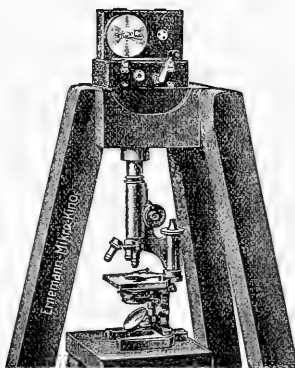
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SCIENCE

FRIDAY, MAY 3, 1912

THE PRACTICAL CLASSIFICATION OF SOILS

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Relation of the Soil to Agricultural Practice.—The comprehensive study of agricultural questions which has arisen in recent years has revealed the necessity for accurate information on the character and distribution of soil conditions. It is being more clearly recognized how fundamentally the soil enters into all questions of agricultural betterment, both scientific and practical. Not only does the intelligent management of the soil rest upon a proper appreciation of the inherent physical, chemical and biological variations in soils in different parts of the country, but the suitability of these to different crops, the adjustment of the crops which can best be produced to the business organization of the farm, its size, equipment, money product, transportation and market facilities, and the social life of the community are involved. The application of the results of the investigation of the institutions for agricultural research—the experiment stations, the colleges of agriculture and the federal and state departments of agriculture—must take account first of all of soil conditions. Types and varieties of crops, methods of culture, tillage, drainage, irrigation and fertilization give better results upon some types of soil than upon others. Those which are well suited to one soil may be a total failure upon some other soil. The experiment stations have often confined their study to one or two types of soil on the central institution farm. It is only within very recent years that the importance of carrying on investigations at substations, upon the several typical soil

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formations which may exist in their territory, has been recognized. In all these and many other even larger questions a knowledge of the variety and distribution of the soils of a territory is of prime importance.

Principles of Classification.—The study of any group of facts or phenomena involves an understanding of the properties in which they may differ, and the systematic representation of these differences requires that the properties of importance be arranged and classified with reference to some controlling interest. Soil is no exception to this general rule, but the application of these principles in the field description of soils in a practical way and from the agricultural point of view presents many and complicated problems.

Definition of Soil.—In the discussion of the classification of soils, the soil should be viewed very broadly so as to include any portion of the earth's surface capable of producing plants. It includes thin, stony material as well as that of great depth and friability. It includes desert regions as well as humid regions. It includes the material as deep as any influence is exerted upon plants growing on the surface.

Requisites of Scheme of Soil Classification.—The classification of soil to be of the largest value should effect the accurate separation of materials with reference to all important inherent agricultural differences. This statement indicates the breadth of the point of view to be taken. It is that of the farmer—agriculture in its broadest sense. The classification should not be confined to any particular section of plant production. It should apply to flowers and forests as well as wheat and cotton. It should have a place for the roughest mountain region as well as for the most intensively tilled garden. To be less comprehensive is to invite arbitrary judgment and corresponding inaccuracy in

the application of the scheme in the field. The distinctions with reference to plant growth and agricultural practise which should be made are differences in, first, chemical composition, including total content of plant food, amount of lime, amount and condition of the organic matter and the solubility of all these, including the presence of alkali salts; second, physical properties including texture, structure, color, moisture capacity, aeration and temperature; third, the climate under which these properties exist. These distinctions which will determine natural plant growth will also make sufficient provision for agricultural practise necessary to produce domestic crops.

The ideal result of the scheme of soil classification is to separate all soil material into types or individuals which are uniform in their agricultural value and distinct from every other type of soil. The soil type must be the unit and the primarily important separation in the scheme. Once the types are recognized they may be grouped according to any selected properties, irrespective of those involved in arriving at their identity.

Difficulties in the Field Separation of Soils.—Having pointed out the properties with reference to which soils should be classified, the next problem is to apply these in a systematic way in the field. Herein arise two kinds of difficulties: First, to classify soils directly by their properties for plant growth is impracticable. Take chemical composition, for example. To classify soils upon the basis of chemical analysis of samples of every acre or even every ten acres is impracticable because of the large amount of labor and time involved. To directly determine the moisture capacity, temperature and other essential factors of plant growth presents similar practical difficulties. The direct

method must, therefore, be set aside. The important crop-producing properties must be correlated with some group of characteristics of the soil which are more easily recognized and grouped, and by this means arrive at individual types of soil which have some measure of agricultural unity and value. The more perfect this correlation of properties the more satisfactory will be the result. The characteristics of the soil which have been most often selected for correlation with its crop-producing properties are the geological. Second. Herein lies the second group of difficulties, namely, in establishing the correct relation between crop-producing power and geological origin, and also in the accurate separation of soil material along geological lines, due to the complexity of the geological processes and materials involved. Attention should be directed here to a point often overlooked, namely, that the separation of soils along geological lines is secondary to their separation according to crop-producing power. The method is an incident to the result, however interesting it may be as a part of the science of geology. Much confusion in work has resulted from the failure to sense this distinction. The soil type is a geological element in the structure of the earth and as such is legitimately investigated by the geologist. Unfortunately, for agricultural purposes, the geologist has seldom carried his separations far enough, due probably to the fact that he has not had the agricultural point of view and, therefore, has not appreciated the kind of distinctions which are demanded for farming purposes. This may be termed the agroeconomic point of view.

Principles which have been used in the Classification of Soils.—The soil has been classified from many points of view. Em-

mons¹ studied the soils of New York between 1835 and 1840 and made somewhat extensive chemical analyses of the soils in the several regions into which the state was divided. This is probably the most extensive of the early surveys and combined the chemical composition with geological origin in arriving at the agricultural separation, a method generally employed by investigators working in this field. The physical properties of the material were also recognized as important, but these several factors were not correlated in any definite way. Owen and Peters² made a very comprehensive study of the chemical composition of the soils of Kentucky. Hilgard³ has made the largest collection of the chemical analyses of soils available in America, in connection with the investigation of the cotton soils, and the soils are classified in the field and indicated on maps with reference to the native vegetation. The mode of formation and physical properties received consideration. Shaler⁴ in an article published in 1891 called attention rather definitely to the relation between the processes of soil formation and the character of the material and pointed out correlated types of plant growth.

In foreign countries a number of men have studied the problem of the practical classification of soils and of these the Russians have been most successful. Dokou-

¹ Emmons, Ebenezer, "The Soils of New York. Natural History of New York," Agriculture, I, 207-360 (1843), 1846.

² Owen, D. D., Geological Survey, Kentucky, Annual Repts., 1855-1875. Peters, Robert, "Chemical Composition of Soils, Marls, Ores, etc., Chemical Analysis A," Pts. I, II, III., 1875-1888.

³ Hilgard, E. W., "Cotton Production," 10th Census, V. and VI., 1880.

⁴ Shaler, N. S., "Origin and Nature of Soils," 12th Ann. Rept. U. S. G. S., Pt. I., 219-345, 1890-91.

chayev with his pupils,⁵ the most prominent of whom is Subertzev,⁶ studied these questions for many years and arrived at what may be termed the most perfect and comprehensive scheme devised up to the present time. Theirs is a genetic system based upon climate, the formation of the soil, and the apparent properties. It was rather a statement of broad groups than the designation in systematic order of the factors, which give rise to agricultural differences in soils.

The credit for definitely correlating the physical properties of the soil with its agricultural belongs chiefly to Whitney⁷ and his associates. By his work the textural properties of the soil, through their influence on the moisture capacity and general climate of the soil, were shown to have a very determinate effect on the crop-producing power of the soil. The adaptation of natural vegetation and of domestic plants largely reflects these properties. Grass is shown to be generally identified with fine-textured soils, corn with loams and truck and other special crops with rather light sandy loams.

The Federal Soil Survey.—In 1899, as chief of the United States Division of Soils, Whitney began the classification and mapping of soils in the field according to their evident agricultural value. At first the physical properties were used almost exclusively as the means of separation. This survey work expanded and many men were employed in the field. Gradually the scheme of classification expanded, under the lash of necessity, keeping always to the fore the agricultural significance of each

separation. Over four hundred thousand square miles were surveyed up to the beginning of 1911, distributed more or less in every state in the union. These surveys have proved their value and more than anything else have demonstrated the necessity of such work as a basis in general agricultural investigations and in education. They have also exemplified the necessity of arriving at definite principles for the classification of soils which in their distribution have little relation to political boundaries. Following the lead of the federal government and as a supplement thereto, many of the states have taken up survey work, some independently and some in cooperation with the federal bureau. All this emphasizes the need for a common basis for work such as the committee on soil classification of the American Society of Agronomy is endeavoring to establish.

While of great value and proceeding upon a broad basis of separation of soil types designed to represent their chief agricultural differences, on the one hand, the work has not always been as accurate as it might have been and, on the other hand, it has not been properly understood or appreciated because the factors which are used in the classification of soils have never been accurately stated. Individual survey men have been left very largely to absorb the scheme of separation from contact with the older men in the bureau and to work it out for themselves from previous training and especially from experience in the field. Apparently the factors which are used in the separation of soils are not always recognized and the grouping of types is often not upon parallel lines or lines of equal significance. The properties which determine differences in value have not been clearly perceived. The corollary of inaccurate grouping is inaccurate boundaries of soil types. As an in-

⁵ Tulaikov, N., "The Genetic Classification of Soils," *Jr. Agr. Sci.*, 3, No. 1, pp. 80-85, 1908.

⁶ Subertzev, N., *Expt. Sta. Record*, 12, 704-712, 1900; 12, 807-818, 1901.

⁷ Whitney, M., U. S. Weather Bureau Bul. 4. Also Buls. S. C. Agr. Expt. Sta., Md. Agr. Exp. Sta. and U. S. Bureau of Soils.

stance of the first inaccuracy the coastal plain is put on a par with the soils of glacial formation, however justified this may seem to be from the point of view of agricultural prominence. In the same line is the correlation of material occurring in the Ohio River bottom in Mason County, Kentucky, with the Norfolk series which is a part of the coastal plain. (Since changed.) The most serious errors in drawing the boundaries of individual types result from failure to appreciate the factors upon which the larger separations are made. These difficulties are pointed out, not to minimize the value of the work done, for they weigh lightly against the large and fundamental value of the surveys which have been completed, and which in the main are sound, but rather with the purpose to illustrate the importance of stating as clearly as possible the factors which are used in the practical classification of soils and the comparison of these with what may be termed an ideal scheme of classification. It is objected by some persons that it is not possible to devise a perfect scheme which is applicable under all conditions. The important point is rather that we now have a fair understanding of the primary factors which produce agricultural differences in soil and that the use of these in the classification, representation and study of soils is of great practical value. We shall attain nearer a perfect system as we accumulate more information on the subject. All of the elements of soil separation which are mentioned in the following pages have been employed in the work of the Bureau of Soils, but they have not been given equal or uniform value.

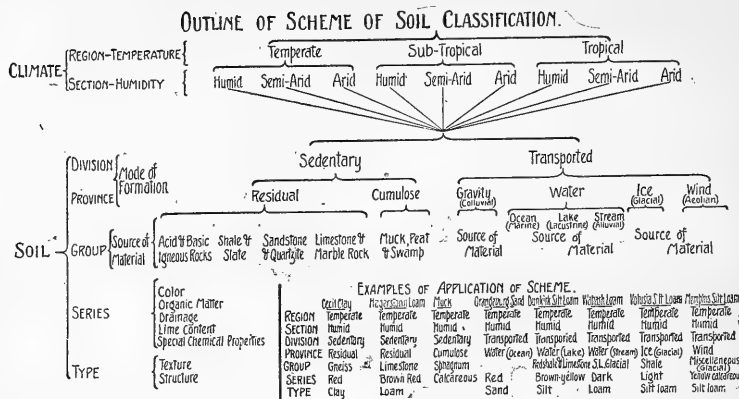
The most comprehensive review of the methods which have been used in the classification of soils is that by Coffey prepared as a thesis for the doctor's degree in George

Washington University under the direction of Dr. George P. Merrill.

The aim of this paper is to organize the factors which have been used in the classification of soils and any others which appear to have a controlling influence on the agricultural value of soil into a scheme which shall point out the fundamental factors involved, and the relation of these factors to the distribution of soils in the field. The requisites and some of the limitations of such a scheme have been stated. It was noted that the crop-producing power of a soil is dependent upon its chemical and physical properties and the climate.

Statement of Plan of Classification.—The climate of a soil has two phases: First, the climate of the region in general, due to its geographic position. Second, the climatic conditions within the soil, due to the physical and chemical properties of the soil itself. Due to the latter two soils of different properties situated under the same general climatic conditions may present different climatic conditions to the plants growing upon them. The temperature and humidity of sand and clay may be very different, which is illustrated by the fact that one is termed an "early" soil and the other a "late" soil.

The physical and chemical properties of a soil are due to its mode of formation and the kind of materials used. The first include the time element or extent of operation of the processes and changes subsequent to the general formation of the material such as drainage, climate, etc. The second include the kind of rocks from which the soil material is derived and may be as diverse as the kinds of rock multiplied into the proportionate mixture of any combination of these. The scheme is, therefore, genetic and in its broader lines purely geological. The relation of these to agri-



cultural properties will be indicated as the scheme is developed.

Climate.—The broadest agricultural divisions in soil are due to climate. Although the soil material were the same (if that is possible), if it occurred under widely different conditions of climate it would have a different agricultural value and should be differentiated.

Climate consists of two primary elements. These are temperature and humidity, or precipitation.

I. *The Region. Temperature.*—We propose to term the groups of soils determined by temperature the *region* and the surface of the earth would be divided into belts or zones corresponding in general to these commonly made, and these may be multiplied if their agricultural diversity proves too great. The temperature has some influence upon the type of processes by which soils are formed and the changes which they are continually undergoing.

II. *The Section. Humidity.*—The groups determined by humidity we would term the *section* and the temperature zones would be subdivided according to the degree of aridity. In the United States three

conventional groups have been recognized, namely, the humid, the semi-arid and the arid. Humidity has an especially marked effect upon the processes of soil formation and brings about distinct physical and chemical differences. In a general way in arid regions physical processes of the decay of rocks are relatively more prominent than chemical processes, resulting in soil which averages coarser in texture. Alkali or the excess of soluble salts is chiefly identified with aridity of climate. These are, therefore, broad distinctions in the properties of soil which should be recognized.

III. *The Province. Mode of Formation.*—The third great factor which determines the properties of a soil is the mode or process of formation. This includes all the processes and forces which have been operative in transforming rocks into soil and imparting to them distinctive physical and chemical characteristics. These are dynamic and, therefore, impress special properties upon the material handled. While several processes are usually operative on the same material, they are seldom equally prominent, and certain conventional groupings have been adopted by

geologists, especially those who have given much attention to soils, for example, G. P. Merrill.^{*} These are (a) general weathering which gives rise to residual material. The type of weathering and the activity of the several forces will depend upon the kind of rock. (b) Decay acting upon organic material to give rise to cumuloose deposits. It differs from weathering, since there is an actual building up of material due to biological activity and biological changes are dominant. These two groups taken together have been termed the *sedentary division*, since the material has not been appreciably moved. Where rocks are involved the soil is likely to rest on rock of the same kind as that from which the soil was formed. The physical as well as the chemical properties of the rock maintain much of their identity in residual soil—for example, quartz bands in gneiss rock and chert masses and other impurities in the different strata of limestone.

The remaining processes involve appreciable transportation of the material and have been grouped together as the *transported division*. Four great agencies of transportation are recognized.

(c) Gravity produces the slow sliding of material down rather steep slopes and in some instances it includes avalanche movement. The material is without organized structure and likely to be rather coarse and thin and of low agricultural value in both extent and adaptation.

(d) Water has been the great transporting and soil-forming agency. Many of the most famous agricultural portions of the earth owe their formation to water, notably the Nile Valley, the American coastal plain and the interior lake plains and stream valleys. It couples a wide range of transporting power with very decided sorting

and in the deposit of the material produces stratification. Thereby nearly all of the areas of soil of distinct textural unity have been derived. Fine clay and clean, uniform sand are equally identified with the agency of water. Stratification implies differences in successive layers, and a shift in the direction or velocity of movement of the water when a material was being laid down may produce great variation in texture, structure and chemical composition. These principles of variation are so well understood that much explanation is unnecessary.

It is worth while to recognize three phases of action of water according to its breadth, extent of movement and to some degree its character. These are oceans (saline waters), lakes and streams. The depth, uniformity and chemical character of the soil formed under each of these influences are likely to be distinct. While water gathers rock material from many sources, each body is likely to have certain characteristics of its material due to the region drained.

(e) Ice in the form of glacial masses has been an extensive and important agency of soil-formation adjacent to the polar regions and in high mountains. Some of the most famous agricultural portions of the world, such as much of the Upper Mississippi River Valley owe their character to this agency. Here again peculiar chemical, physical and, to some extent, topographic features are imparted to the material handled. The kind of rock encountered, the rate and direction of movement of the ice and the minimum of chemical decay and leaching have determined the agricultural features of many regions formed by glacial ice. The soil conditions in New York State especially exemplify these distinctions.

Ice does not accomplish sorting or strati-

^{*} Merrill, G. P., "Rocks, Rock-weathering and Soils," pp. 411, 1897, Macmillan Co., N. Y.

fication and is likely to produce a range in texture and a degree of compactness of the lower part of the soil section not found in soils formed in other ways. It is often difficult to distinguish between material deposited by pure ice action and that modified by glacial water due to the melting of the ice.

(f) Wind has not been so distinctively a soil-forming agency as water and ice, though it has very generally contributed to the result.⁹ Like water it effects sorting and stratification, but the range in texture of material carried is very much more narrow, the type of stratification is different, and the material has a wider areal unity in chemical and physical properties. The most distinctive soil formations whose origin has been referred to the action of wind are sand dunes and loess. The former represents a large amount of material which has been rolled along the surface of the ground. It is usually a fine sand and shows sorting to the extent that very fine material is almost wholly removed. While the origin of loess has been referred to the settling of dust from the atmosphere, the American deposits exhibit properties which cause the adequacy of this theory to be questioned. In northern China, where this material was first recognized, its origin was attributed by Von Reichtofen to the agency of wind. At any rate it is a distinct material and seems more closely associated with this mode of formation than any other. The possible chemical and physical properties of wind-blown material entitle it to recognition in the scheme of classification.

IV. *The Group—Source of Material.*—The kind of rock from which a soil is formed is generally recognized to have a

⁹ Free, E. E., "The Movement of Soil Material by the Wind," Bul. 68, Bureau of Soils, U. S. Dept. of Agriculture, pp. 272, 1911.

large influence on its chemical and physical properties. The mineral character of the rock and the extent of decay determines the texture of the soil. The composition of the rock influences both the composition and texture of the soil in a distinctive way. The same rock may be transformed into soil by several agencies and again the same agency may act on several kinds of rock. The product is likely to be equally diverse in its capacity to support plants. A large variety of rocks might be recognized as influencing the character of soils. The fact that soil has usually been derived from quite a variety of rocks, makes it necessary to keep the divisions here as broad as possible, since only such can be recognized with any degree of accuracy. These are rather large groups and in practice special distinctions are likely to be made on this basis. The primary groups to be recognized may be mentioned as acid and basic rocks of igneous origin, and with these the gneisses, schists and similar secondary rocks are likely to be included; shale and slate, sandstone and quartzite, limestone and marble. Plant remains constitute a separate and distinct class of material from which soil may be formed and the proportion of these which enters into any given formation may give distinctive character.

Often the mingling of material from several kinds of rock may impart peculiar character to the soils of a drainage system or a lobe of glacial ice. The red alluvial soils of the Red River drainage system owe their character largely to the red Permian formations of Oklahoma and Texas. The glacial soils of west central New York are largely dependent for their character upon the several shale, limestone and sandstone rock formations crossed by the ice in reaching that position. The line of movement of the material with reference to the gen-

eral rock structure will largely determine the relation of the soil to any particular rock formation.

V. *The Series*.—The soil series is the most complex of the separations made in practise. Unlike the others, it does not rest upon a single character. Its separation requires the employment of a group of correlated characters. These are more intimate in their nature, more concerned with the material itself than the bases of the larger separations. Having applied those, the final grouping of types or units is determined first of all by

(a) *Color*.—Color as a physical property is not of great importance, but when considered in connection with the properties which are correlated with color it is of the greatest significance. Color is usually indicative of the proportion of organic matter, of the drainage, of the state of oxidation, of the proportion of lime carbonate and to a degree of the mineral composition of the soil.

(b) *Organic Matter*.—The proportion of organic matter is suggestive of the nitrogen content of the soil. It has a large influence on the availability of the mineral particles. It is indicative of the natural drainage, of the proportion of lime carbonate and of the activity and type of micro-organisms.

(c) *Lime Carbonate*.—The presence of a fair amount of this constituent has been pretty generally recognized as essential to a fertile soil.

(d) *The Total Plant Food Content of the Soil*.—While the average soil contains a relatively large quantity of the mineral plant food constituents, soils which are decidedly deficient in some one or more of these are sufficiently abundant to warrant the special consideration of this property. It does not necessarily involve general chemical analysis and may often be in-

ferred from other properties. The solubility of the soil constituents, while seldom a distinctive series basis of separation, is often indicative of other characteristics of the soil and as alkali, especially, of the type of climate. These several elements will seldom, if ever, have equal value in deciding a separation. They can not well be applied independently in general field work. In some cases one, as color, may be dominant; in another drainage, and in still other separations it may be the lime content which will determine the grouping.

If one consider all soil series together without reference to their grouping according to the broader bases of classification, such as formation, etc., it will generally be observed that soil series are chiefly distinguished by chemical differences, that is, differences in composition and chemical form. Organic matter is suggestive of the nitrogen content, solubility, etc. The presence of lime is a matter of composition. Differences in rock material mean certain differences in composition. On the other hand, the last or unit separation of soils is based chiefly on physical properties—texture and structure. The series includes all material having the same characteristics, but varying in texture from the coarsest to the finest.

VI. *The Type. Texture and Structure*.—The fineness of the material of which a soil is composed is the most broadly influential of the physical properties of a soil. Through its influence on porosity, moisture relations, aeration, temperature, tillage properties, etc., it is probably the most dominant in deciding crop adaptation and agricultural value. The more distinct textures of clay, loam, silt and sand are generally recognized. These rest upon the proportion of particles of different sizes and a great variety of proportions may be recognized and given names. These are

being multiplied. A question requiring further consideration is the number of sizes of particles—separates—to be recognized and the limits of these. Several systems of groupings are now in use.¹⁰ The finer the particles the greater is the influence of a given mass of them upon the character of the soil. Many more divisions should, therefore, be made in the fine material than in the coarse material. It is an open question whether, as survey work has been done in the United States, sufficient divisions have been made below the sand classes. Undoubtedly field separation of materials by hand examination is not likely to be more refined than is possible with the divisions now generally made. However, finer distinctions in the mechanical analysis of material smaller than 0.005 mm. may explain some variations in types of soil not otherwise recognized and these form the basis for more detailed study of individual types.

The structure of a soil as determined by the order of stratification and the thickness of the layers may also be the basis of type separation. This is independent of general structural differences due to the general mode of formation and the characters of the rock.

The soil type is the unit for soil study and should be as nearly alike in all parts as is possible. It is the most important grouping of material primarily because it does represent the chief physical differences in soils. The next most important grouping is the soil series and these two will be most generally identified with particular crop and agricultural interests in practise. This does not minimize the value of the larger separations, which, as has been suggested, are essential to reasonable accuracy in these last two groups.

¹⁰ Briggs, L. J., et al., "The Mechanical Analysis of Soils," Bul. 24, Bureau of Soils, U. S. Dept. of Agr., 1904.

Of course the final test of a survey must be in the field man who applies these principles to a particular set of conditions. Owing to the intimate overlapping of several fields of natural science in this work it is evident that he should be a man of broad training, including especially geology and the principles of soil fertility, and he should have keen power of observation and correlation. Scarcely any experience or training which the field man may possess but finds use in the ideal soil-survey man.

ELMER O. FIPPIN

CORNELL UNIVERSITY

THE BRITISH ASSOCIATION

A PRELIMINARY program has been issued for this year's meeting of the British Association, which, as already announced, is to take place at Dundee from September 4 to 11. The meeting will be the eighty-second of the series, the twelfth in Scotland, and the second in Dundee, the association having previously met in that city in 1867.

The opening meeting will be held in the Kinnaird Hall on Wednesday evening, September 4, when Professor E. A. Schäfer, F.R.S., will assume the presidency and deliver his inaugural address. In the same hall the first evening discourse will be delivered on Friday, September 6, by Professor W. H. Bragg, F.R.S., on "Radiations Old and New," and the second on Monday, September 9, by Professor A. Keith, on "The Antiquity of Man." The reception room and offices will be established in the Albert Institute, and a considerable proportion of the sections will have their meeting-rooms in the University College.

Arrangements have been made with the railway companies for the issue to members of return tickets at reduced fares, available for the period of the meeting and eight days after, and excursions during and after the meeting, for the purposes of scientific field-work, are expected to prove particularly important this year. The famous Alpine flora of Clova and Glenesk, the fossil fish beds of Dura Den, and the geology of the Stonehaven region and of the Western Highlands

are among the objects of contemplated visits. The President will have the assistance of a body of vice-presidents representative of the administrative, educational, ecclesiastical and commercial interests of Dundee and its neighborhood, headed by the Lord Provost of the city, Mr. James Urquhart, LL.D., and in the notice of entertainments to be arranged in connection with the meeting the names of the Earls of Moray, Strathmore and Camperdown and of Lord Kinnaid appear as hosts.

PENSIONS AT THE UNIVERSITY OF CHICAGO

As has already been noted in *SCIENCE* the trustees of the University of Chicago have arranged a system of retiring allowances, and for this purpose propose to set aside a sum not less than \$2,000,000. The trustees do not reserve the power of altering the statute to the disadvantage of those in the service of the university at the time it was enacted. The full statute reads as follows:

1. Any person in the service of the university and sixty-five years of age who holds the position of president of the university, director or associate director of the university libraries, or university examiner, and who has been for a period of fifteen years in the service of the university, in a rank not lower than assistant professor; and any person in the service of the university and sixty-five years of age, who has been, for a period of fifteen years in a rank not lower than assistant professor, a member of the teaching staff of the graduate schools of arts, literature and science, the graduate divinity school, the law school, or the colleges, may retire from active service, or be retired by the board of trustees on an annual allowance to be computed as follows:

(a) For fifteen years' service, 40 per cent. of the average annual salary received during the five years immediately preceding the time of retirement.

(b) For each year of service beyond fifteen years, 2 per cent. of the said average annual salary.

But no annual allowance shall exceed 60 per cent. of the said average annual salary, nor shall it exceed \$3,000.

A person between sixty-five and seventy years of age, eligible to a retiring allowance, may retire, or may be retired by the board of trustees; at the

age of seventy years he shall retire, unless the board of trustees specially continues his service.

2. The widow of any person in receipt of, or eligible to, a retiring allowance at the time of his death, shall be entitled to one half of the amount of his allowance during the period of her widowhood, provided she was his wife at the time of his retirement and had been his wife for not less than ten years before his death.

3. No right or claim under this statute shall vest in, or accrue to, any person until a retiring allowance shall become due and payable under and in accordance with it; and the exercise of the right or power of the board of trustees to terminate the service, or reduce the salary, of any person shall not give to such person any claim or cause of action hereunder against the university.

4. The board of trustees reserves the right to suspend the retiring allowance of any person, who, while in receipt of such allowance, accepts an appointment on the staff of any other institution of learning.

5. The obligation of the university to pay retiring allowances shall be neither greater nor less than its obligation to pay salaries to persons in active service, so that if misfortune should compel a percentage reduction of salaries, retiring allowances may be reduced in the same proportion.

6. Nothing in this statute shall preclude the board from granting other retiring allowances, or allowances on account of disability to officers of administration or instruction, or their widows, where the term and character of service, or the special circumstances of the case make the same appropriate, or from adding a term of years to the actual years of service of a person who enters the service of the university as an associate professor or of higher rank.

7. The board of trustees retains the power to alter this statute, but the alteration shall not have any effect as to persons of the class or rank mentioned in Art. 1, at the time of such alteration.

SCIENTIFIC NOTES AND NEWS

MRS. MARY MAURY WORTH, of Richmond, Va., and other descendants of Matthew Fontaine Maury, the eminent hydrographer, have presented to the United States through President Taft the Maury medals, commissions and correspondence.

DR. KARL CHUN, professor of zoology at Leipzig, has been awarded by the University

of Göttingen the prize of the Otto Vahlbruch foundation, of the value of \$3,000.

DR. PIETRO ALBERTONI, professor of physiology in the University of Bologna, has been elected a member of the Italian senate.

DR. A. HRDLÍČKA, of the U. S. National Museum, has been named a corresponding member of the Société d'Anthropologie de Bruxelles, Belgium.

PROFESSOR FÜRBINGER, the director of the anatomical institute at Heidelberg, retires at the close of the summer semester and is succeeded by Professor Braus.

AN expedition for the study of malaria from the department of tropical medicine and hygiene of Tulane University, under the direction of Dr. Charles Cassedy Bass, sailed from New Orleans on April 20 for Central America.

DR. MARCUS BENJAMIN has just been informed that his valuable collection of the portraits and autograph letters of the presidents of the American Association for the Advancement of Science received the award "diploma d'honneur" from the exposition that was held in Turin, Italy, last summer.

DR. AMOS W. PETERS, of the Carnegie Food Laboratory in Boston, has been appointed biochemist in the research department of the Training School for Feeble Minded Children, at Vineland, N. J. So far as is known this is the first appointment of the kind ever made. Five years ago, the Vineland Training School opened a department of research for the scientific study of mental defectiveness of which Dr. Henry H. Goddard was made director. Studies in growth, heredity, classification of defectives, the measurement of intelligence have been carried on and now the work is being extended in other lines. Dr. Peters has worked in zoology and biochemistry at the University of Illinois and later at the Harvard Medical School with Dr. Otto Folin. He will carry on studies in metabolism and brain chemistry. He will begin the new work about July 1.

AMONG recent lectures of scientific interest at the University of Illinois are the follow-

ing: three lectures on "Heredity," by Professor W. E. Castle, of Harvard University; "The Paleozoic History of Illinois," by Dr. T. E. Savage, of the Geological Department of the university; "Foreign Students and Student Life at the University of Berlin," by Dr. Wilhelm Paszowski, of the University of Berlin; "Morals and Moral Ideals of the Japanese," by Professor Inaze Nitobe; "Some Methods that have been tried in University Business Organization," by Dr. H. C. Bumpus, business manager of the University of Wisconsin; "European Bridges," by Professor F. O. Dufour, of the department of civil engineering.

A JOINT meeting of the Columbus Section of the American Chemical Society with the Ohio State University Sigma Xi Society was held on April 17, when the address of the evening was delivered by Professor R. A. Millikan, of the University of Chicago, on "New Proof of the Kinetic Theory of Matter and of the Atomic Theory of Electricity."

BEFORE the Society of Sigma Xi of Columbia University, Professor Henry E. Crampton gave on May 2 an illustrated lecture on "A Zoologist's Trip to South America."

ASSOCIATE PROFESSOR JAMES R. WITHROW, of the Ohio State University chemical department, recently delivered a lecture before the Kenyon College Chapter of the Phi Beta Kappa, on the "Destructive Distillation of Heartwood."

ON returning to Europe in September Captain Raold Amundsen will make his first address before the Norwegian Royal Geographical Society in Christiania. A few days later he will lecture before the Royal Geographical Society in Berlin, then in other cities in Germany, Austria and Switzerland. On November 18 he will address the Royal Geographical Society, London.

DR. HOWARD T. BARNES, MacDonald professor of physics in McGill University, will lecture before the Royal Institution of Great Britain on May 31, on Icebergs and their Location in Navigation.

THE Rev. George William Knox, professor of philosophy and the history of religion in the Union Theological Seminary, died on April 25, at the age of fifty-nine years.

PROFESSOR CHARLES HENRY CHANDLER, emeritus professor of mathematics at Ripon College, died, on March 29, from heart failure, at the age of seventy-one years. He graduated from Dartmouth College in 1868, taught at Antioch College from 1871 to 1881, and at Ripon College from 1881 until his retirement on the Carnegie Foundation in 1906. He was for many years a fellow of the American Association for the Advancement of Science.

THE death has occurred of Mrs. Margaret E. Stinson, who for forty-six years was connected with the Massachusetts Institute of Technology, latterly in the care of the chemical apparatus. During her long connection with the institute she assisted and befriended many of the students.

DR. WILLIAM OGLE, distinguished for his contributions to vital statistics, died on April 12 at the age of eighty-four years.

THE nineteenth summer meeting of the American Mathematical Society will be held at the University of Pennsylvania on Tuesday and Wednesday, September 10-11, 1912.

THE Society of American Bacteriologists will hold its annual meeting in New York City at the close of this year.

THE next annual meeting of the Biochemical Association will be held at the College of Physicians and Surgeons, Columbia University, on Monday evening, June 3. Besides the usual business meeting there will be a scientific program consisting of the presentation of reports of recent researches by members of the association. This scientific session will be the first of an annual series of similar meetings. Abstracts of the reports will be published collectively in the June issue of the *Biochemical Bulletin*.

MR. J. B. TYRRELL, the geologist and mining engineer, is to lead the Ontario government expedition into the north to locate the five-mile strip which the province is to receive

from the Dominion. Although the route has not been settled, the party will probably proceed first to Winnipeg about the end of May, and thence to Lake Winnipeg to Port Nelson, much of the journey by canoe. At the mouth of the Nelson River, some time will be spent in locating the ten-mile strip which Ontario will have as a terminus for the Temiskaming and Northern Ontario Railway, should it be decided to extend the line there. The party will then head for the south, and a larger part of the five months will be taken up in exploring the 50-mile stretch along Hudson Bay, anywhere in which the government has a right to choose its five-mile strip.

PROFESSOR C. H. EIGENMANN, of the Indiana University and the Carnegie Museum, after a successful exploring trip on the rivers of Colombia, returned by the *Alemanía* on April 15. The main object of this expedition was to secure a series of the fishes of Colombia. After collecting in the lower courses of the Magdalena River, he ascended that river to an elevation of one thousand feet at Girardot. From here a side trip was made to Bogota. After returning to Girardot, he went by pack-train, *via* Ibagué, Cartago, Cali to Caldas on the Pacific slope. From Caldas he went by train to Buenaventura on the Pacific Coast. In this trip collections were made in all the streams crossed and especially in the Rio Dagua, flowing into the Pacific from an elevation of 5,000 feet to tide water. From Buenaventura he went up the San Juan, first by steamer and later by dug-out canoe with Indians to Istmina. From Istmina the divide between the Pacific and Atlantic slopes was again crossed by horse to Tambo. From Tambo, at first small canoes and later one larger canoe took him and his effects on the San Pablo and Rio Quibdo to Quibdo. As the navigation of all of these streams was very irregular on account of the unusually dry season, special arrangements were made to take him from Quibdo to Rio Sucio where, on account of a scare of pirates, the regular steamer from Cartagena was delayed awaiting the arrival of a company of soldiers from

Cartagena. This brought him to Cartagena on April 2, only three days beyond the date on which he hoped to sail.

ON April 20 Governor Dix signed a bill appropriating \$500,000 for the rehabilitation of the New York State Library. This makes a total of \$622,000 appropriated for this purpose since the destruction of the library by fire in March, 1911. Beyond the fundamental general reference material, the State Library will specialize in science only so far as may be necessary to serve such agencies or departments of the state government as are doing scientific work. Good working collections will be made in geology, zoology, entomology, botany, with more particular attention to the economic phases of these subjects, and in chemistry as related to agriculture, the arts and commerce. The fact that the New York State Museum is administratively connected with the State Library will mean that in the subjects falling within the scope of the museum's work special attention will be given to the establishing of a notable collection of books.

THE Smoot bill to consolidate all national parks and monuments under one Bureau of National Parks, has been reported favorably by the Senate Committee on Public Lands. The measure has the endorsement of the Interior Department and the American Civic Federation.

THE University of California will establish a temporary outpost this summer in the Yosemite Valley. At the conclusion of the summer session (which extends from June 24 to August 4) the summer students of botany and zoology will go to the Yosemite for two weeks. The botanical students will put into practise the training received at Berkeley, by field studies on the classification and zonal distribution of the flowering plants and ferns in that portion of the Sierra Nevada. Meanwhile those who have had the summer session courses in zoology will study the habits and characteristics and ways of life of the mountain birds and mammals of the Yosemite region. For five weeks during the summer a

party of summer session students will be encamped south and east of Mount Diablo, engaged in collecting fossils, identifying extinct animals of which they are the remains, and mapping the faunal zones which record the changes of species over periods of uncounted hundreds of thousands of years. Still another summer outpost of the university will be the Summer School of Surveying, at Camp California, near Swanton in Santa Cruz County. Here some 200 men will be learning how to make maps, survey lands, run railroads and canals and lay out irrigation and drainage systems.

THE *Journal* of the American Medical Association states that the originator and president of the recent international hygiene exposition at Dresden, Dr. Lingner, has petitioned the local authorities to establish a national museum of hygiene in Dresden. It is contemplated to use the hall, "*Man*" (*Der Mensch*), which proved the greatest attraction for visitors to the exposition, as the nucleus of the museum. The museum is to be designed to realize the important principle that every one shall gain by direct inspection the knowledge which will fit him for a sanitary and intelligent conduct of his life. For the completion of this self-instruction, popular weekly lectures are to be held, which will gradually cover the entire field for the care of health. In addition, the management of the museum shall provide scientific lectures and demonstrations for professional people, that is, for physicians, officials, engineers and the leaders of industry. An academy of scientific character is also proposed to supplement the museum. Lingner will present to the museum the objects exhibited at the exposition, which represent a value of \$250,000. The land, which is reckoned at about 6,000 square meters, is to be donated by the city of Dresden. The expense of building and furnishing are reckoned at about \$875,000. The expense of building will be defrayed first out of the surplus from the international hygiene exposition, amounting to \$250,000, while the government of the province (Saxony) will give the rest. The annual expenses are estimated

at about \$62,500. Of this, the city of Dresden will furnish \$37,500; the special income of the museum from entrance money and fees for attendance at lectures, etc., is estimated at \$20,000. The rest, it is hoped, will be supplied by gifts. The museum is to include three chief divisions, "Der Mensch," the historical division and the ethnologic division.

UNIVERSITY AND EDUCATIONAL NEWS

NEARLY two hundred thousand dollars have been subscribed to the equipment fund in the past two weeks, according to the announcement of the Alumni Fund Committee of the Massachusetts Institute of Technology.

THE Sheffield Scientific School of Yale University has received from Mr. Murray Gugenheim, of New York City, \$20,000 as a nucleus of a fund for additional instruction and equipment in the branches of mining and metallurgy.

By act of legislature of the state of Pennsylvania, dated April 20, a charter of incorporation, with the power to grant degrees, was given to the Carnegie Technical Schools, and the name of the institution is changed to the Carnegie Institute of Technology.

WORK has been commenced upon the construction of the new Ceramics and Mining Engineering Laboratories of the University of Illinois. These buildings are to form a part of the group of engineering buildings to be located upon ground east of Mathews Avenue, which has recently been acquired by the university. The contracts for the new Transportation Building and the Locomotive Testing Laboratory will soon be let.

PROFESSOR FILIBERT ROTH, head of the forestry department of the University of Michigan, who recently accepted the chair of forestry at Cornell, has reconsidered his decision and will remain at Michigan where the regents have agreed to provide additional facilities for the forestry school.

PROFESSOR FREDERICK E. BOLTON, professor of education and director of the school of education in the State University of Iowa, has accepted a call to become head of the depart-

ment of education in the State University of Washington at Seattle, and will begin his work at that place in September.

DR. ROBERT CHAMBERS, JR., has accepted an appointment as assistant professor of histology and embryology in the University of Cincinnati. Dr. Chambers is on the teaching staff of the Marine Biological Laboratory, Woods Hole, Mass., and has held the position of lecturer in the University of Toronto for the last three years. He now has a fellowship in Professor E. B. Wilson's department.

DISCUSSION AND CORRESPONDENCE

THE NAME AND BRAIN OF THE GAR

TO THE EDITOR OF SCIENCE: From my former pupil and assistant, Asa C. Chandler, A.B., now on the staff of the University of California, I have recently received a copy of his paper, "On a Lymphoid Structure Lying Over the Myelencephalon of *Lepisosteus*," constituting No. 2 of Vol. 9 of the "Publications in Zoology" edited by Professors Ritter and Kofoid of that institution. Every such contribution to the knowledge of this genus is to be welcomed as helping to remove the "reproach to the comparative anatomists of this country that the brain of this [almost] exclusively American form should not have been fully elucidated."¹ Material and literature for the profitable discussion of the structure and homology of the newly described organ are now inaccessible; but a careful

¹ The sentence here quoted is from my review of Wiedersheim's "Comparative Anatomy of Vertebrates," SCIENCE, N. S., Vol. 27, May 8, 1908, under the caption, Fig. 159. The bracketed word is introduced in qualification of the too sweeping statement as to the distribution of the genus; according to Jordan and Evermann it is represented in China by a single species, *L. sinensis*. Never having seen an example of this species, or even a picture or description of it, I had forgotten its existence not only when the sentence quoted was written, but also when trying to enumerate my errors ("Some Mistakes of the Writer and Others," etc., SCIENCE, N. S., Vol. 34, July 21, 1911). Are the other readers of this journal equally ignorant, or forgetful, or simply indifferent, or needlessly sparing of my feelings?

reading of the paper has led me to make some notes which I should submit to the writer were we still associated and which I hope will not be without interest and profit to others.

1. *The Generic Name of the "Gar."*—Mr. Chandler and the editors adopt *Lepisosteus* as introduced by Lacépède in 1803 rather than *Lepidosteus* as corrected by the elder Agassiz and—till lately—almost universally employed. With all admiration for President Jordan (another former pupil who, I think, suggested or at least sanctioned the change), I feel that this is too rigid an application of the "priority rule." Had an ignorant or heedless person first christened the "duck-bill" as *Ornisorhynchus* should we have perpetuated a blunder that would offend all scholars? I doubt it. Conceding, however, that in this matter each has a right to his own opinion and usage, I protest against the change in the title of my paper, "On the Brains of *Amia*," etc.² where the original *Lepidosteus* is converted into *Lepisosteus*. I hold that the latter form has no etymologic standing, and—excepting in quotation—would no more use it than a profane expletive.

In this connection it may be properly mentioned that the specific name of the "alligator gar" is not *tristæchus*, as used by Mr. Chandler on p. 87, but *tristæchus*, from στροχός.

2. *The Contour and Constitution of the Gar's Brain.*—The dorsal aspect is represented in the text-figure A. It is very unlike the corresponding figure of Balfour and Parker as reproduced by Wiedersheim. Although I have exposed several gar brains, unable now to refer to them, I will not undertake to say which of these figures is the more nearly correct; possibly difference of species or age may account for some discrepancies, certainly not for all. Chandler's figure contains no indication of the thalamic region (diencephalon or "thalamencephalon") or explanation of its omission. The outline is represented by a continuous line; it should be interrupted at the place of emergence of the olfactory nerves even if the nerves themselves are omitted.

² Amer. Asso. Adv. Sci., Proc., 1875.

3. *The Names of the Parts.*—Why should the two cephalic ("anterior") pairs of lobes be designated as "anterior" and "posterior lobes of the cerebrum" when there can be no doubt that the first pair are the hollow olfactory bulbs and the second the solid striata (unfortunately called "prothalami" by me in 1875)? And since the, so to speak, "specific" names of these two parts, of the "optic lobes," and of the "trilobed cerebellum," were deemed adequate for their designation, and since the segmental constitution and names were in no way concerned in the general treatment of the subject, why should the region supporting the newly described lymphoid structure be singled out for the application of the ponderous title, "myelencephalon" when "oblongata" or "medulla oblongata" would have sufficed? "Oblongatal gland" would be unobjectionable. Excepting, perhaps, his own coinage, "Isthmus rhombencephali," for a region since commonly admitted to be non-existent or negligible, *myelencephalon* is one of the most objectionable components of the neurologic nomenclature selected by the late Professor His, adopted by the Anatomische Gesellschaft, and blindly, hastily or slavishly employed by many in this country. Its only logical justification would be the adoption of Owen's "myelon" in place of "medulla spinalis." Even if *myelencephalon* is preferred, should not "metencephalon" have been added as a synonym? It is a more appropriate equivalent of Von Baer's "Nachhirn"; it is quite as familiar to most anatomists; it was preferred by the majority of the committee on nomenclature of the Association of American Anatomists in 1897; and, as has been pointed out by me on several occasions, the prefix lends itself readily to useful and euphonious compounds, *metacele*, *metaplexus*, *metatela* and *metapore* ("Foramen of Magendie"). These considerations render me hopeful that when there comes a subsidence of "Hisolatry" and of the prevailing obsession of most American anatomists for ideas and words "made in Germany," the last encephalic segment will be known as *metencephalon* and the last but one as *epencephalon*.

To offset in some measure the foregoing criticisms of the terminology of Mr. Chandler's paper let me commend his use of pial, dorsal, caudad and cephalad.

BURT G. WILDER

A FISTULA IN THE DOGFISH

In a shipment of dogfish pups (*Mustelis canis*) sent from Woods Hole to the Biological Laboratory of New York University during the summer of 1910, there was a specimen about 20 inches long with a celomic fistula which had been closed in a curious manner. The opening was on the ventral surface, just posterior to the left pectoral fin. Externally it was not conspicuous, the tissue of the oval scar being much the same color as the surrounding skin, although evidently of a somewhat different texture.

On laying open the body cavity it was found that the fistula had been plugged by a growth from the left lobe of the liver, which had filled the wound completely without adhering to the structure of the body wall. The edge of the cicatrice, after the liver had been drawn away intact, was smooth and thoroughly healed.

ROBERT CUSHMAN MURPHY

MUSEUM OF THE BROOKLYN INSTITUTE

NOTE ON "SOME EARLY PHYSIOGRAPHIC INFERENCES"

AMONG the interesting physiographic comments quoted from early writers by Dr. Emerson on page 374 of SCIENCE for March 4, the one by James Hall is evidently misinterpreted. The quotation is as follows:

About midway between St. Louis and the mouth of the Ohio, masses of limestone rock are seen on either side, which, though now unconnected, have the appearance of once having formed a continuous ridge crossing the river in an oblique direction.

This is supposed by Emerson to refer to the bluffs bordering the new trough of the Mississippi River near Thebes, Ill., where it leaves its old valley and crosses into another formerly occupied by the Ohio River. It seems practically certain, however, that Hall had in

mind a conspicuous ridge of limestone beds dipping steeply northeastward, which appears on the west bank of the Mississippi in Perry county, Mo. Just below Wittenberg, this ridge has evidently been obliquely intersected by the river, the obvious southeastward continuation in a direct line appearing on the east bank in the picturesque series of isolated rock masses known locally as the Devil's Bake-oven and Devil's Backbone; the latter ending abruptly at the town of Grand Tower, Ill. This is about three fifths of the distance from St. Louis to the Ohio, while the Thebes cut is only a short distance above the mouth of the Ohio; and at the cut neither the rock masses nor the oblique direction are especially evident.

CHARLES A. HART

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SCIENTIFIC BOOKS

The Mechanical Factors of Digestion. By WALTER B. CANNON, A.M., M.D., George Higginson Professor of Physiology, Harvard University. Illustrated. London, Edward Arnold; New York, Longmans, Green and Co. 1911. Pp. 227.

The motor activities of the muscle tube which forms the digestive system has long been a favorite subject of investigation, and a considerable mass of valuable information is at our disposal. But this evidence often shows a marked lack of harmony, even though the observations were made upon the same organ in the same animal. The fault, however, lay not so much with the experimenters, as with the methods employed; there was no single procedure which was applicable for the study of the entire gastro-intestinal canal without grave operative interferences, and these interferences often altered or even abolished the very function which was to be investigated. It was therefore natural that varying interpretations and consequent confusion should arise. In 1896, a method was developed by means of which the motor functions of the entire digestive tube, from pharynx to rectum, could be observed without

any operation whatsoever; or the effects of operations (resection of nerves, portions of the gut, etc.) could be studied after the animal had fully recovered. Cannon achieved this result by means of the X-ray. This method depends on the fact that food mixed with a salt of bismuth (subnitrate or oxychloride; an iron salt has also been used lately) becomes opaque to the X-ray. If the subject under investigation, man, dog, cat or other animal, ingests this bismuth paste, the bolus may be observed on the fluorescent screen, for the bismuth mass blocks the X-rays and betrays its presence to the observer by a vibrating shadow on this screen. The progress and change in shape of this shadow disclose to the eye of the expert observer the character of the muscular activity of the digestive system.

Besides originating and perfecting this method Cannon has also been the foremost modern investigator of gastro-intestinal motility. The experimental results with which he enriched physiology during the last fourteen years have, however, only recently been collected by him in a monograph, and this monograph is the first authoritative attempt to give a complete, critical study of motor digestive activities as a whole, using as a guide the results gained by his new method. Although Cannon's work forms by far the largest part of our modern knowledge of the motor activities of the gut, his monograph is by no means a one-sided presentation of the results obtained by his laboratory; other important work, gained by various experimental methods, is critically considered and brought into relation with the direct testimony which the X-ray affords.

The entire subject matter is considered by Cannon in sixteen concise chapters, and the chapter headings will indicate to the reader how completely the field has been covered. I., General Features of the Movements of the Alimentary Canal, and Methods of Investigation; II., The Movements of Mastication and Deglutition; III., The Nervous Control of Deglutition; IV., Conditions Affecting the Activities of the Cardia; V., The Movements of the Stomach; VI., The Effect of Stomach

Movements on the Contents; VII., The Stomach Movements in Relation to Salivary Digestion and Gastro-enterostomy; VIII., The Passage of Different Foodstuffs from the Stomach; IX., The Acid Control of the Pylorus; X., The Correlating Functions of the Pylorus, and some Conditions Affecting It; XI., The Movements of the Small Intestine; XII., The Movements of the Large Intestine; XIII., Auscultation of Gastro-intestinal Sounds; XIV., The Intrinsic Innervation of the Gastro-intestinal Tract; XV., The Extrinsic Innervation of the Gastro-intestinal Tract; XVI., Depressive Nervous Influences Affecting Gastro-intestinal Movements. At the end of each chapter a complete list of the more important literature references is given, and this list will be a great convenience for many research workers.

While these chapter-headings show the scope of the book, they give no indication of their interesting, and attractively presented, contents. Although it is not possible here to discuss all the valuable and interesting sections of the book, and they will be found in every chapter, attention may be called to Cannon's theory of the acid control of the pylorus. The pylorus, a sphincter muscle which guards the opening of the stomach leading to the intestine, regulates the passage of the food into the duodenum (upper part of the small intestine). Depending upon the character and state of the food in the stomach, this gatekeeper feeds at intervals a spurt of food into the gut. By what mechanism is this accomplished? How can this ring of muscle-fibers differentiate, for example, between carbohydrates, which are permitted to leave quickly, and proteids, which remain for a considerable period of time in the stomach?

This remarkable behavior of the pylorus was first explained satisfactorily by Cannon, and his theory, in brief, is as follows: Free acid above the sphincter causes a relaxation of the muscle ring and a peristaltic wave is thus able to discharge a quantity of chyme into the duodenum. But as soon as the chyme reaches the duodenum, its acidity produces a closure of the pylorus. The acidity of the

chyme, however, is soon neutralized by the alkaline bile and pancreatic juices, and then the free acid in the stomach produces again an inhibition of the sphincter tonus and another quantity of chyme is driven out. This hypothesis has been tested by Cannon in numerous ways. He has shown, for example, that anything which delays the appearance of free acid delays the onset of the discharge from the stomach; that hastening the appearance of free acid hastens the time of discharge; and by means of a fistula, he was able to observe that the appearance of free acid closely precedes the first gastric discharge into the duodenum. In addition, Cannon showed that free acid causes opening of the pylorus in the *excised* stomach of a cat, thus proving that the control of the pylorus is independent of the central nervous system and resides probably in the local nerve plexus. Free acid, therefore, above the gastric sphincter causes it to relax, and this explains why carbohydrates leave the stomach much earlier than proteids, for both these food-classes stimulate the secretion of gastric juice, as Pavlov has shown, but the proteids unite with the acid as it is produced, forming acid albumen; there is thus no free acid available for a considerable period of time, and, as shown above, free acid is necessary to cause a relaxation of the pylorus. There is no such difficulty with carbohydrates; as soon as the free acid appears the pylorus relaxes, and the crackers, potato-mush, or whatever carbohydrate was fed, is at once transferred to the gut by the peristaltic waves of the stomach.

The evidence that free acid *below* the sphincter, in the duodenum, causes closure of the pylorus, is just as conclusive, for various investigators had shown that acid in the duodenum slows the output of chyme from the stomach, and this must be due to an effect on the pylorus, for Cannon demonstrated that gastric peristalsis was not stopped during this condition. Another support was furnished by the observation of Pavlov that acid solutions leave the stomach much more slowly in dogs with a pancreatic fistula than in normal animals. This is easily explained by the

fact that absence of the alkaline pancreatic juice permits the chyme to remain acid in the duodenum for a longer period, and thus the stimulus which causes closure of the pylorus remains effective until the food material becomes neutral or alkaline. Cannon studied the effects of ligation of the larger pancreatic and bile ducts on the rate of discharge from the stomach and gives a chart which shows the marked delay caused by this interference. The stimulus which causes the closure of the pylorus is mediated through the myenteric nerve plexus, for after severance of the entire muscular coats of the duodenum just below the pylorus, Cannon found that the discharge of the stomach content was considerably more rapid than in normal animals: the acid chyme undoubtedly still produced its usual stimulus in the duodenum, but this stimulus could not reach its destination, the pyloric sphincter, because its path had been destroyed.

From the foregoing it will be seen that Cannon's theory seems adequately and simply to explain one of the most remarkable functions in the body, and it is of theoretical interest that the same agent may exert diametrically opposite effects, the sign of this effect being dependent upon the locus of the stimulation.

It may be said, in short, that this concise monograph by Professor Cannon gives a balanced and authoritative view of the present state of our knowledge regarding the motor mechanism of digestion under normal and experimentally modified conditions. In addition, the reader will find that the presentation is lucid and that dogmatic statements are absent.

JOHN AUER

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CHEMICAL TEXT-BOOKS

The Elements of Qualitative Chemical Analysis with Special Consideration of the Application of the Laws of Equilibrium and of the Modern Theories of Solution. By JULIUS STEGLITZ, Professor of Chemistry in the University of Chicago. Parts I. and II. Fundamental Principles and their Ap-

plication. Parts III. and IV. Laboratory Manual. New York, The Century Co. 1911.

As the appearance of Ostwald's "Foundations of Analytical Chemistry" in 1894 showed the way by which it would be possible to transform analytical chemistry from a somewhat mechanical process to a scientific system based on definite laws, and as the investigations of A. A. Noyes and Bray furnished the facts necessary to enable one to select the methods most exact and rapid, so the appearance of this work has marked a milestone in the progress of the science of qualitative and quantitative analysis. In this work the author has collected and applied the observations and deductions which have resulted from the researches of the last score of years in the field of physical chemistry and has furnished a rational explanation for reactions which have hitherto been merely empirical. The work is divided into two parts, the theoretical and the applied. How inspiring it would be if a teacher could always start with a class already trained in physics and mathematics and, with more than the usual time at his disposal, use this method, knowing that he was turning out thinking chemists instead of mechanical analysts. Unfortunately in many cases neither the time nor the previous training of the students is such as will enable him to use this book to advantage, so far as the undergraduate student is concerned, but this is the fault, not of the book, but of conditions governing the methods of instruction and arrangement of courses in different institutions.

Part I. of Vol. I. contains a discussion of the fundamental principles which lie at the foundation of analyses, such as ionization, chemical equilibrium and the law of mass action, osmotic pressure, the colloidal condition and the conditions governing precipitation. All of these questions are discussed in a very clear manner with constant reference to examples in the way of reactions in qualitative analysis. In Part II. we find a general discussion of the methods used in testing for the metallic ions with a detailed statement of each step in the process, great emphasis being

placed on the reasons for each step and upon the bearing of the dissociation theory and the law of mass action upon the question under consideration. The theory of the separation of some of the metals by the precipitation with hydrogen sulphide and the theory of complex ions, as well as a discussion of the process of oxidation and reduction, the latter being regarded as involving essentially the loss or gain of electrons, are treated in a very thorough manner.

Although the views here expressed regarding oxidation and reduction may not be generally accepted the subject is admirably presented from the author's point of view.

In Vol. II. we find a discussion of the reactions of the individual metals and acids, especially those reactions which are made use of in qualitative analysis and a very full and clear course in systematic analysis. It would be very desirable if every student of chemistry could follow the course mapped out in this book and work out all the reactions according to the principles given in Vol. I.; but in many instances the time allotted to a course in qualitative analysis is too short to permit the use of such a detailed method.

Every teacher of chemistry and every advanced student of chemistry should study carefully the material contained in this book.

To one who is or is to be a chemist its value can not be overestimated. To the beginner in qualitative analysis its thoroughness and scope should be an inspiration and lead to the very desirable conception of quantitative chemistry as much more than mechanical proficiency in manipulation.

A Handbook of Organic Analysis, Qualitative and Quantitative. By H. T. CLARKE, B.Sc. (Lond.), Lecturer on Stereochemistry in University College, London. With an introduction by J. NORMAN COLLIE. Longmans, Green & Co.

The Identification of Organic Compounds. By G. B. NEAVE, M.A., D.Sc. (St. Andrew), and I. M. HELLBON, Ph.D. (Leipzig), F.I.C., Lecturers and Demonstrators, Department of Chemistry, Glasgow and West

of Scotland Technical College. New York, Van Nostrand Co. \$1.25 net.

In the first of these volumes efforts have been made to supply the organic chemist with a scheme of analysis and identification of the groups and compounds comparable to the scheme used for the identification of the metallic ions and acid groups. A system of this kind has been greatly needed; but, owing to the great similarity of organic compounds, so far as their constituents are concerned, and to the great diversity, so far as their behavior is concerned, up to the present has not been successfully developed.

By classifying the substances according to the elements they contain and by studying their action with water, alkali, acid, reducing agents, etc., the authors have been able to separate the substances generally met with into groups which in turn are subdivisions of classes. Having reached this point, the exact division to which the substance belongs can be determined by specific tests. Detailed methods are given for testing for the different classes of compounds, and a table of many of the more important substances with their physical and chemical properties serves as a valuable and handy reference. While this scheme of analysis may seem very crude as compared with the one we use in organic chemistry, it is a step in the right direction and worthy of careful study and testing.

The second of these books has the same object in view, but is on a less systematic and comprehensive scale. The general reactions seem too few and indefinite and the special reactions not specific enough to enable one to identify organic compounds by its aid unless considerable reference is made to other records.

Contemporary Chemistry. A Survey of the Present State, Methods and Tendencies of Chemical Science. By E. E. FOURNIER D'ALBE, B.Sc.; A.R.C.S.; M.R.I.A., author of "The Electron Theory, etc." New York, D. Van Nostrand Co. \$1.25 net.

The author has written a very interesting "birds-eye view of the whole field of modern

chemistry." While not intended as a history of chemistry, all the recent discoveries of importance have been included and their importance and relations to other phenomena have been pointed out. One who has worked in some other science than chemistry, as well as students of this subject, will find this book instructive and well worth reading.

Progressive Problems in General Chemistry.

By CHARLES BASKERVILLE, Ph.D., Professor of Chemistry, and W. L. ESTABROOKE, Ph.D., Instructor in Chemistry, College of the City of New York. Heath & Co. 1910.

The authors have brought together a large number of problems covering all the phases of chemical action. This book will furnish the teacher a mine of material from which he may select examples to meet the needs of the students as the different subjects are studied and so test their understanding of the principles involved. The solution of problems, such as these, is of special value in the early stages of the study of chemistry and especially with young students, as it demands the power of applying the facts and reasoning from them and not simply the ability to commit facts and reactions to memory. The value of this work might be increased by adding at the beginning of each subject a general statement as to the methods of solving the problems in this section and the principles involved for the aid of those who are not sufficiently familiar with the subject to work it out entirely independently.

J. E. GILPIN

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Bibliography of Non-Euclidean Geometry, including the Theory of Parallels, the Foundations of Geometry, and Space of n Dimensions. By DUNCAN M. Y. SOMMERVILLE. London, Harrison and Sons. 1911. 8vo. Pp. xii + 403.

In these days, when a non-Newtonian mechanics, based on the principle of relativity, is forcing itself upon the attention of the scientific world, it is instructive to notice how valuable the non-Euclidean and n -dimensional

geometries have become, although it is only about forty years since they began to be appreciated thoroughly and studied systematically. The vast and increasing interest which these subjects have aroused is indicated by the fact that Sommerville's Bibliography contains the titles of about 2,300 works on non-Euclidean geometry, of which nearly 800 were published in the decade 1901-10, and 1,800 works on hyperspace, of which 700 belong to the same decade. Let us glance briefly at a few of the principal ways in which these sciences have shown themselves to be of importance, not only in mathematics, but also in the related domains of mechanics, logic, psychology and epistemology.

In the first place, a flood of light has been thrown on the epistemological problem of the nature of our spatial concepts. Kant's famous doctrine of the *a priori* synthetic nature of these concepts is seriously threatened by the modern geometry, and will require considerable modification, if it is not entirely rejected.

In the realm of psychology, also, these theories have a decided bearing on the distinction between the perceptual space of experience and observation and the conceptual idealized space of mathematics proper. The former space has a physiological basis, principally visual and tactual, and the theorems of its geometry can have only an approximate meaning. Now the striking fact is that this natural geometry of experience is much more nearly non-Euclidean than Euclidean. For instance, as Mach observes, the space of tactual perception, namely, the skin, corresponds roughly to a two-dimensional Riemannian space. Moreover, with all the refinements of astronomical observation the space of visual perception can obviously never be proved to be Euclidean.

The recent developments of deductive logic as typified by the symbolic logic of Peano and Bertrand Russell unquestionably owe much to non-Euclidean geometry; and they in turn have helped to make the foundations of geometry secure at last, after two thousand years of misplaced confidence in Euclid.

In the domain of mechanics, if in addition

to the three Cartesian coordinates of a moving particle we interpret the time as a fourth coordinate, we obtain a space of four dimensions, and thus establish a useful correspondence between three-dimensional kinetics and four-dimensional geometry. Now the remarkable thing about this correspondence is that whether the original kinetics is Newtonian or non-Newtonian, the corresponding geometry is in each case of a non-Euclidean type.

Perhaps the highest significance, however, of these seemingly pathological theories is due to the light which they shed on other, less suspicious branches of mathematics. For instance, the geometry of hyperspace provides a convenient language in which to express the theory of functions of several variables; and in particular the projective geometry of n -space is closely connected with the algebra of forms, or quantics, involving $n+1$ variables. Moreover, the point-geometry of 4-space helps us to understand the sphere-geometry of ordinary 3-space, because the spheres of 3-space form a four-dimensional aggregate.

Non-Euclidean geometry, also, derives its chief importance from its bearing on Euclidean geometry. It often discloses unsuspected bonds of relation between apparently disconnected Euclidean developments. It brings out the inner meaning of the process of building metric geometry on the basis of projective geometry. It gives a clear insight into the theory of surfaces of constant curvature. Of great value is the correspondence between the group of projective transformations which leave a quadric surface invariant and the group of non-Euclidean movements. Another correspondence of similar importance is that which exists between the group of conformal point-transformations of a Euclidean 3-space and the group of movements of a non-Euclidean 4-space.

Sommerville's Bibliography consists of three parts, a chronological catalogue, a subject index, and an author index. In the chronological catalogue the titles of the works published in each year are arranged alphabetically according to the authors. Later editions, translations and reviews are included.

In the subject index no titles are given, but references are given to the year and author, so that the corresponding title can be easily found in the chronological catalogue.

It is obvious that a scientific bibliography like this serves a very useful purpose to the student and investigator, especially when it is well arranged and possesses a high degree of completeness, as is the case here. With Sommerville's book at his command the worker in the field of non-Euclidean or n -dimensional geometry is unusually well equipped for referring quickly to the literature of his subject.

ARTHUR RANUM

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Report on the Dune-Areas of New Zealand, their Geology, Botany and Reclamation.

By L. COCKAYNE, Ph.D., F.L.S., Department of Lands, New Zealand. Printed by John Mackay, government printer. 1911.

Because of extensive dune-areas and the impending danger to valuable lands from encroachment, the Dominion government commissioned Dr. Cockayne to conduct a careful investigation of the dune conditions in New Zealand and to embody certain recommendations as to the reclamation of the dune lands and the protection of threatened territory in a formal report. This report, which is an extension of the author's earlier researches, we now have from the government printer. The paper is divided into two parts; the first deals with the geology and botany of the dune-areas and the second with various methods of reclamation. In Part I. the geology of these dynamic habitats is very excellently handled under such subheads as: The Material of Dunes, Dune Building on the Coast, The Effect of Solid, Flexible and Inflexible Obstacles, and the Effect of Climate, General Topography of the Dune-areas in New Zealand, Movements of Dunes and Dune-sand. There are more than 300,000 acres of dune lands in North and South Islands, where occur chains of sandhills of irregular form, which are generally divided in places by basin-like hollows of greater or less extent. The wind plays a great part in constantly changing the form of

the dunes, the position of the hills, and in modifying the slope angles. Hills in all stages of growth and decay, and basins in the process of being hollowed out or being filled up appear on every side. The wider dune areas appear like seas of sand with the ridges as more or less stationary billows with their scanty vegetation.

Under "Botany" is treated such ecological matters as: Climatic Factors, Heat, Light, Moisture, Soil, Topography and Biotic Factors. The most characteristic plants with their growth-forms and adaptations are treated in considerable detail. The leading dune plants in New Zealand are: *Spinifex hirsutus* (Gramineæ); *Scirpus frondosus* (Cyperaceæ); *Euphorbia glauca* (Euphorbiaceæ); *Carex pumila* (Cyperaceæ); *Calyptegia Soldanella* (Convolvulaceæ); and *Arundo conspicua* (Gramineæ). These plants are distinguished as "sand-binders" in distinction to the following which are called "sand-collectors": *Caprosoma acerosa* (Rubiaceæ); *Pimelea arenaria* (Thymelæaceæ); *Cassinia leptophylla*, *C. fulvida*, *C. retorta* (Compositæ); *Festuca littoralis* (Gramineæ); *Calamagrostis Billardieri* (Gramineæ); and *Scirpus nodosus* (Cyperaceæ).

The commoner plant associations represented are: Sand-Grass Dunes, Pes Capræ Dunes, Shrub Dunes, Lakes and Swamps, Dry Hollows and Stony Plain. The various dune species are noted in tabular form with various ecological notes. This list includes 147 species of which 82 are endemic, 43 Australian and 15 South American. Fifty-one families and 104 genera are represented in this number.

The methods in vogue the world over for the artificial fixation of dunes are based upon those which nature herself uses and these are here enumerated as fifteen "fundamental principles" with which plant ecologists are more or less familiar. Marram-Grass, *Amphiphaea arenaria*, and the Tree-Lupin, *Lupinus arboreus*, are noted as the best of the "sand fixers" for the region under consideration. The efficiency of these two species is compared in considerable detail. Under "Methods of Reclamation" the methods of preparing and

planting Marram-Grass and Tree-Lupin are discussed in detail and suggestions are included for the post-planting management of the plantations. The possibility of checking sand movement by means of sand-fences and protection belts is considerably elaborated. Protection belts are merely narrow bands of Marram set at the junction of the advancing sand and the invaded ground. Such a belt is efficient usually for only a few years unless it is constantly watched and repaired.

The report closes with a discussion of afforestation of the dunes, which method seems to the author to be the only means of establishing the desired static condition over the dune complex. Little tree-planting upon the dunes has been done in New Zealand under difficult conditions, but the method is strongly recommended. The more important trees and shrubs for dune afforestation in these islands are as follows: *Olearia Traversii*, *Pinus pinaster*, *Pinus halpensis*, *Araucaria excelsa*, *Cupressus macrocarpa*, *Pinus radiata* (most valuable), *Pinus muricata*, *Tamarix gallica*, *Lupinus arboreus*, *Acacia melanoxylon*, *Salix caspica*, *Populus deltoides*, *Populus balsamifera*, *Populus fastigiata* and *Alnus glutinosa*. Besides these species, all of them promising dune holders, *Pinus laricio*, *P. pinea*, *P. Coulteri* and *P. Strobus* grow "quite well" on the dunes of New Zealand. A final list of plants (over 200 species) suitable for dune cultivation in these islands contains useful information as to the habitat, growth-form, etc., for the various species, many of which are North American.

This very interesting and well-written paper is well illustrated by means of sixty-nine halftones and three etchings, and includes a bibliography of sixty-six general works and seventy-three references to the literature of New Zealand Dunes.

RAYMOND J. POOL

THE UNIVERSITY OF NEBRASKA

Aerial Navigation. A Popular Treatise on the Growth of Air Craft and on Aeronautical Meteorology. By ALBERT F. ZAHM. New York, D. Appleton & Co. 1911. 8vo. Pp.

xvii + 497; 58 illustrations in text and 32 full page plates.

Amid the flood of ephemeral popular and pseudo-scientific books on this subject which have appeared in England and America during the past two years, here is one that rests on a solid foundation, fit to carry the superstructure of subsequent progress. The author, distinguished as a pioneer investigator of aerodynamics in America, has been intimately acquainted with Langley, Chanute and the Wrights, and a close student of aeronautics in Europe. Therefore Dr. Zahm is eminently qualified to write a book, which in character resembles the reviewer's earlier and smaller "Conquest of the Air," a revised edition of which Dr. Zahm's later and more detailed publication seems to render superfluous. However, the most recent achievements in aeronautics chronicled in any book are already antiquated and surpassed when presented to the reader and conclusions based thereon require corresponding modification.

Authors naturally give prominence to those subjects with which they are most familiar and, therefore, while the reviewer accorded first place to the Ocean of Air, Dr. Zahm puts Aeronautical Meteorology last, having compiled this section largely from other authors and thereby somewhat neglected its status in this country. The two preceding divisions of the book are: the Growth of Aerostation, in which both spherical and dirigible balloons are considered, and the Growth of Aviation, treating of early attempts to fly, the modern glider and the power aeroplane. An appendix contains technical papers and three letters of Benjamin Franklin, written from Paris in 1783 describing the first balloons, which are reprinted from "The Conquest of the Air." The author refrains from prophecies concerning future developments of craft either lighter or heavier than air, since progress in the art of aerial navigation has been so rapid as to baffle conjecture concerning their ultimate applications.

In conclusion, it may be said that the work can be recommended, to either the lay or scientific reader, as admirable in its material

and method of presentation. The numerous illustrations are wisely chosen and well rendered and the few errors noticed in the text are mostly typographical. A misleading misprint occurs in the statement that the first successful dirigible balloon in 1885 sailed from Calais to Paris and returned to its place of departure, which really was Chalais-Meudon, a suburb of Paris.

A. LAWRENCE ROTCH¹

BLUE HILL METEOROLOGICAL OBSERVATORY

SPECIAL ARTICLES

HEATING OF LOCAL AREAS OF GROUND IN CULEBRA CUT, CANAL ZONE²

THE marl shales, through which Culebra Cut extends, in the region opposite the Culebra railway station, have, from time to time, on exposure to the atmosphere, become hot. The intensity of this heat has varied from noticeably warm to a temperature sufficient to readily char wood, without, however, causing it to burst into a flame. The duration of this heating has been from a few days to several weeks. These shales are dark, thin bedded, soft and easily crumbled, and some of the layers are largely fine basic tuff, loosely cemented by lime. Other beds contain more carbonaceous material, with some local partings of lignite an inch to a foot or more thick. The relatively unweathered character of these basic sediments is evidence that they were derived from nearby volcanic mountains, and the carbonaceous and lignitic layers in them indicate shallow water and swamp conditions of deposition. The presence of fossil oysters, pelecypods, corals and foraminifera show that these shallow estuaries were marine, and that they existed in early Tertiary time. Dr. T. Wayland Vaughn, of the U. S. Geological Survey, examined some of the specimens on the ground and gave it as his opinion that they are Oligocene in age. The evidence so far points to a shallow water connection between the Atlantic and the Pacific during Oligocene time.

¹ This review was written immediately before the lamented death of Professor Rotch.—Ed.

² Published by permission of the chairman of the Isthmian Canal Commission.

After exposure to the atmosphere by drilling, or blasting, certain local areas of this formation become, in the course of a few days, warmed up, and as the heating goes on the carbonaceous matter in the shales is gradually oxidized off and they tend to assume a gray to dull reddish color. The first working hypothesis entertained in looking toward a solution of this heating phenomenon was that possibly the heavy blasting had furnished heat enough to break down the calcium carbonate present to the oxide form, and that ground water and atmospheric moisture reacted on this to slake it and thus probably generate sufficient heat to start the oxidation of the carbonaceous material. This hypothesis was, however, rendered untenable by three lines of evidence:

1. The heating was much more local than the calcium carbonate, and the carbonaceous matter.

2. The heating bore no definite relation to the lime and carbon content of particular beds.

3. Colonel Gaillard, in charge of the Division, informs me that in some instances the heat began in the holes some time after they had been drilled, but before the ground had been blasted at all.

Another line of inquiry was suggested by finding a small amount of pyrite in some of the beds which were heating. It was suspected that this, through its oxidation, was a factor in furnishing the initial heat of the action. In April, 1911, samples of the beds then heating were sent to the chemical laboratory of the U. S. Geological Survey with instructions to make qualitative tests for sulphur and other products that might serve, through oxidation, as the mainspring of the action. These tests revealed the presence of sulphuric acid to the amount of 1.92 per cent., also minute crystals of gypsum. This confirmed the hypothesis that pointed to the pyrite present as the substance acted on by atmospheric oxygen to develop the initial heat.

The most aggravated case of heating so far noted is now going on in Culebra Cut, about 350 yards north of the foot of the stair at the observation tower near Culebra Station. The

mass of heated ground here is about 500 feet long by 20 feet wide, and the action reaches a depth of perhaps 15 or 20 feet. Blue smoke, which contains a high percentage of sulphur dioxide, issues from vents in the mass, and fragments of wood inserted in these are readily charred and consumed. A small amount of steam may also be detected emanating from local moist spots, but this is mainly due to the vaporization of ground water. In the investigation of this heated mass samples were taken, and these were tested qualitatively for sulphuric acid and for sulphates of calcium, aluminium and magnesium. The tests were made by Mr. Jacobs, of the Hospital Laboratory Staff at Ancon, and they revealed the presence of all of the above substances, both in the shale and as the white coating on the moist spots and steam vents of the mass. The yellow deposit near the larger vents is sulphur. Sulphuric acid, especially, was shown to be present in considerable quantity. The origin of the sulphuric acid here was at first a puzzle, because the examination of many samples, with the naked eye and with the microscope, failed to reveal the presence of pyrite. Finally samples of eight to ten pounds were taken, ground with water in a large mortar for some minutes, and then concentrated to a few ounces by washing or "panning." This concentrate showed a high content of pyrite, much of which could scarcely be seen with the naked eye. Under the microscope very small crystals of pyrite were noted; also considerable magnetite, present as black sand, and some sub-angular to fairly rounded grains of quartz.

The mainspring of the action here then, as in the other instances observed, has undoubtedly been the oxidation of the pyrite. The reasons why this oxidation has been so rapid and effective, seems to be as follows:

(a) The finely divided, almost microscopic, character of the pyrite gives maximum surface exposure to atmospheric agencies and greatly promotes oxidation.

(b) The very warm, moist atmosphere. The tropical sun shining directly on dark rock surfaces produces a temperature sufficiently

high to greatly promote oxidation, especially in the presence of slight moisture.

(c) Once oxidation of the pyrite has been started the heat thus generated tends to accelerate chemical action and thus the heating increases in geometric progression.

(d) When the heat of pyrite oxidation reaches the comparatively low temperature of oxidation of the hydrocarbons present in the lignitic shale, they, too, become oxidized and still further add to the temperature. Finally the fixed carbon content tends to become oxidized, at least in part, and gives maximum intensity to the action.

(e) Some heat is also generated by the action of the free sulphuric acid on the calcium carbonate for the formation of gypsum. Other minor chemical actions added their quota to the total heat.

As the temperature rises all chemical activity is vastly stimulated and the heating increases to a maximum. After the most readily oxidizable substances are consumed the heat gradually dies down toward normal temperatures, which may be reached in a few weeks or months. The intensity and duration of the heat depends largely upon the percentage of finely divided pyrite, volatile matter and fixed carbon in the rocks.

Some of the geological considerations suggested by a study of this phenomenon are:

(a) Chemico-thermal springs. Whenever jointing fissuring or change of groundwater level gives free access of oxygen-bearing surface waters to beds which contain the necessary finely divided pyrite, and carbonaceous matter, a heating up of such beds is likely to result. Groundwater flowing over such heated beds, and coming to the surface in the general vicinity of them, would constitute thermal springs.

(b) Should a rise of land surface bring pyrite-bearing beds from subaqueous to terrestrial conditions, oxidation of the pyrite might, in the course of a year, give local redbeds that would otherwise require centuries of atmospheric action to produce. Of course it is recognized that no very extensive redbeds could be produced in this way.

(c) The very fine pyrite sparingly disseminated through the carbonaceous shales, herein described, seems to have resulted from the action of sulphur, from decaying animal and vegetable life, on the ferro-magnesian silicate fragments which are abundant in these sediments.

DONALD F. MACDONALD,
Commission Geologist

CULEBRA, C. Z.,
April 1, 1912

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

WASHINGTON MEETING, DECEMBER, 1911

THE thirteenth session of this society was held at the Carnegie Institution in Washington, D. C., on December 27-29, 1911, with President E. C. Pickering in the chair. There were sixty-four members of the society in attendance besides many friends. Nine persons were elected to membership, making a total of more than 270 members.

Six sessions were held, two of which were joint meetings with Section A of the American Association for the Advancement of Science. At the joint sessions Professor E. B. Frost presided in the double capacity of vice-president of Section A and first vice-president of the Astronomical and Astrophysical Society of America; and for these sessions a special program was arranged comprising addresses by Professor Lewis Boss on "Recent Researches as to the Systematic Motions of the Stars," by Professor E. H. Moore, retiring vice-president of Section A, on "The Foundations of the Theory of Linear Integral Equations" and by the Reverend Joel H. Metcalf on "The Asteroid Problem."

The society's scientific program included thirty-two papers and also reports from the committees on comets, photographic astrometry and cooperation in the teaching of astronomy. A new committee on asteroids was created with members, E. W. Brown (chairman), J. H. Metcalf, G. H. Peters and A. O. Lensehner.

The following members were in attendance at the Washington meeting: Misses L. B. Allen, H. W. Bigelow, A. J. Cannon, M. M. Hopkins, E. A. Lamson, Mary Proctor, S. F. Whiting, Messrs. A. T. G. Apple, E. E. Barnard, S. G. Barton, L. A. Bauer, L. Boss, J. A. Brashear, E. W. Brown,

C. A. Chant, H. S. Davis, C. L. Doolittle, E. Doolittle, R. S. Dugan, J. C. Duncan, J. R. Eastman, W. S. Eichelberger, F. E. Fowle, E. Frisby, E. B. Frost, C. H. Gingrich, A. Hall, W. M. Hamilton, J. C. Hammond, H. B. Hedrick, G. A. Hill, W. J. Humphreys, H. Jacoby, H. H. Kimball, W. F. King, F. B. Littell, F. H. Loud, E. O. Lovett, C. A. R. Lundin, Jr., J. H. Metcalf, W. I. Milham, J. A. Miller, S. A. Mitchell, W. M. Mitchell, H. R. Morgan, C. P. Olivier, G. H. Peters, E. C. Pickering, J. S. Plaskett, R. W. Prentiss, W. F. Rigge, F. E. Ross, A. L. Rotch, H. N. Russell, F. Schlesinger, A. N. Skinner, H. T. Stetson, O. Stone, E. D. Tillyer, A. B. Turner, F. D. Urie, R. W. Willson, D. T. Wilson, R. S. Woodward.

New members were elected as follows: John August Anderson, Johns Hopkins University, Baltimore, Md.; Zaccheus Daniel, Allegheny Observatory, Pittsburgh, Pa.; Walter M. Hamilton, 2307 Washington Circle, Washington, D. C.; H. H. Kimball, Weather Bureau, Washington, D. C.; William Francis Rigge, Creighton University; Harlow Shapley, The Observatory, Princeton, N. J.; Vesto Melvin Slipher, Flagstaff, Ariz.; Albert Harris Wilson, Haverford, Pa.; Charles Clayton Wylie, Laws Observatory, Columbia, Mo.

The program of the meeting included the following papers and reports:

A Device for Facilitating Various Forms of Computation: E. W. BROWN.

The device consists of a frame and a carrier which supports a number of tapes. On these tapes small oblong pieces of cardboard are pasted, the members to be summed being written on the pieces of cardboard. It is essentially a device for avoiding the frequent rewriting of the same number when it has to enter into a calculation in many different ways. It is being used for the summation of many small harmonic terms at numerous time-intervals and for the formation of double-entry tables which consist of ten or more terms of the type $A \cos (i\theta + j\phi + a)$ where i, j are integers, a, A constants and θ, ϕ increase uniformly with the time. It will probably be also used for the analysis of numerous observations at equal time-intervals into harmonic terms whose periods are known or have been previously determined, as, for example, in obtaining the tidal constants of a port from hourly observations of the tide height.

The Lesson of Joseph Piazzi's Life: H. S. DAVIS.

Piazzi's career is followed from his birth, through

his student days in Milan, Turin and Rome, and his professional days in the universities of Genoa, Malta, Ravenna, Cremona and Rome, and while getting wider experience in Paris and Greenwich preparatory to beginning his long period of astronomical observations at Palermo, where he built an observatory on the royal palace.

The method of his observing for the large catalogue of stars, his discoveries of certain stellar proper motions, his wide range of observations and of writings on astronomical and geodetic subjects, are narrated to elucidate the influence which this Theatine priest exerted on the science of his and later days, and inversely to exemplify the influence which had been exerted on him by his environment and by his intercourse with Laplace, Lagrange, Delambre, Bailly, Cassini, Herschel, Wollaston, Oriani, Cagnoli and other notable men of astronomy. It is further shown how his discovery of Ceres was not altogether an accident, nor by any means his greatest achievement, but was the natural by-product of his plan of work and his persistent diligence; and that all the many and valuable fruits of his quarter-century of labor were but the outgrowth of an unselfish devotion that had adopted as its motto the words of Seneca: "At mehercules non aliud quis aut magnificentius quaesierit aut didicerit utilius, quam de stellarum siderumque natura."

(This paper will be published in *extenso* in "Makers of Astronomy," soon to be issued by the Fordham University Press, New York, as companion to "Makers of Electricity.")

The Astronomischer Jahresbericht (an Announcement): H. S. DAVIS.

A brief historical summary of the founding and maintaining of this review of astronomical publications, its plan and scope, and to what extent its purpose has been attained. Its future, since assumption of the editorship by Professor Dr. Fritz Cohn, on the retirement of Dr. Berberich, who succeeded to the editorship on the death of Professor Dr. Wislicenus, its founder.

The Variability of Polaris: JOEL STEEBINS.

The variation in the light of Polaris was detected by Hertzsprung and confirmed by King. Assuming the spectroscopic period of 3.9681 days, Hertzsprung found the light-curve to be approximately a sine-curve with double amplitude 0.17 mag., and King found a similar curve with variation greater than 0.10 mag. Both of these results were from photographs. Observations by the writer with the selenium photometer give a similar

curve of the same phase, but of much smaller amplitude, the approximate range being 0.057 mag. It is highly probable that the amount of the visual variation is likewise about 0.06 mag.

The Asteroid Problem: JOEL H. METCALF.

In ninety years from January 1, 1801, to 1891, 323 asteroids were discovered. In the last twenty years about 427 have been added. The rapid multiplication of discoveries and the probable existence of 1,500 brighter than the 14th magnitude demands greater cooperation and division of labor in this field. Except for special investigations the work should be photographic, which gives great facility for observation of old asteroids as well as the discovery of new ones. The importance of the investigation in the light of the discovery of Eros and the Jupiter group of asteroids and the probable existence of still more interesting bodies is increasingly obvious.

Magnitudes, Colors and Spectra of Standard Stars within 17° of the North Pole: J. A. PARKHURST.

This paper describes the determination of the "visual" and photographic magnitudes, color-indices and spectral classes of all the stars down to the B. D. 7.5 magnitude, from declination $+73^\circ$ to the north pole. There are 666 stars within these limits. The instrument used was a camera having a Zeiss doublet of "ultra-violet" glass, also a 15° prism of the same material. The aperture of each is 145 mm. and the focal length of the lens 814 mm.

The photographic magnitudes were taken from Seed plates exposed 6.5 mm. inside the focus, and the opacity of the images was measured with a Hartmann "mikrophotometer." To obtain the "visual" magnitudes images were taken in focus on Cramer trichromatic plates through a "visual luminosity" filter, and the diameters of the images measured under the microscope. The spectral classes were estimated on the Harvard system from the objective prism plates. The magnitude scale was determined on the "absolute" system, directly by sensitometer squares on the extra-focal plates, and indirectly through the Pleiades stars on the focal plates. The measures were reduced by using the Müller and Kempf Potsdam visual magnitudes of the white stars in each field, and reduced to the Harvard system by subtracting 0.29.

Curves were shown giving comparisons with the results of Schwarzschild, Müller and Kempf and Mrs. Fleming; also the relation between color-index and spectral class, and between the color-index and Müller and Kempf's estimates of color.

A Comparison of Dr. Peters's Celestial Charts with the Photographic Charts of the Sky: J. G. PORTER.

The value of star-charts lies, first, in the completeness with which they represent the sky, and secondly, in their availability for use at the telescope.

Four of the photographic charts of the sky, taken at Algiers and Bordeaux, were compared with Dr. Peters's celestial charts, the stars in corresponding regions being carefully counted. In every case the photographic charts contain fewer stars, the percentages running from 51 to 81, and the average being 67 per cent. That is, the visual charts contain on the average 50 per cent. more stars than the photographic charts.

Dr. Peters's charts are pretty complete down to the twelfth magnitude. The photographic charts, therefore, are by no means complete to the twelfth magnitude.

On the photographic charts the images of all but the brighter stars are too faint to see without brilliant illumination, and the configurations of the fainter stars are difficult to trace. Hence these charts are ill suited for use with the telescope.

Two conclusions follow from this comparison. First, the visual charts, so far from being superseded by the photographic charts, are much superior both in their fullness and in their practical usefulness.

Secondly, the photographic charts while ostensibly showing stars to the fourteenth magnitude, really go hardly lower than the eleventh and a half. Some of this discrepancy may be due to the difference between the photographic and visual scales; yet in any case it is clear that in the matter of these charts photography has accomplished far less than was claimed for it, and less than should have been done to justify the expenditure of time and money.

The New Twin Photographical Telescopes of the U. S. Naval Observatory: GEORGE H. PETERS.

This paper is a continuation of one given at the meeting of the society at the Yerkes Observatory in 1909, entitled, "On the Construction of Astronomical Photographic Objectives at the Naval Observatory." It describes the progress in construction and adjustment of the triple photographic objectives of 10 inches aperture and 110 inches focal length. These new lenses and their mechanical parts, forming a twin photographic telescope, are now practically completed, and are

erected in position on the old 26-inch mounting. The tests for errors of adjustment in collimation and refraction are exemplified, together with the methods employed in correcting them.

The Use of Special Topics in Teaching Astronomy: SARAH F. WHITING.

The large numbers who should study elementary astronomy for information and culture should be taught to handle the books of an astronomical library and to express themselves clearly in connected discourse.

To these ends a method more frequently used in literary subjects may well be used—the method of "special topics." A large class for this exercise must be divided into parallel sections; the topics must be given out with bibliography and suggested outline, and the presentation of the topics before the class rated for excellence of outline, form of presentation in language and manner.

Such series of topics as the following have been found practical.

1. Historical topics, some of which may be presented in connection with the biographies of astronomers.

2. A series of topics to show the knowledge of astronomy at different epochs—astronomy of the Bible, astronomy of Homer, astronomy of Milton, astronomy of Shakespeare.

3. The progress of astronomy as related to instruments and mathematical methods. The development of the telescope, of calculus, logarithms, etc.

4. A set of topics to show the immense cost in money and labor to obtain facts—eclipse expeditions, expeditions to obtain solar parallax.

5. Great observatories.

6. Special studies of celestial objects—Halley's comet, net in Orion, etc.

The Orbit of the Spectroscopic Binary, β Scorpii: J. C. DUNCAN.

The variability of the radial velocity of the brighter visible component of β Scorpii was discovered by Dr. V. M. Slipher at the Lowell Observatory in 1903. In 1908 he found that the star's spectrum showed a sharp, non-shifting K line. The writer of the present paper has determined the orbit of the binary from seventy-nine spectrograms made by Dr. Slipher in 1908, 1909 and 1911.

Measurement of the spectrograms was rendered difficult by the scarcity and diffuseness of the spectral lines. In addition to the K line, two

lines of hydrogen and three of helium were all that could be measured. The H line of calcium is concealed by the broad H of hydrogen. On some of the plates the presence of the fainter component of the binary is made evident by the doubling of the lines of hydrogen and helium, so that on these plates three different velocities are indicated—that of each component of the binary and that of the K line.

The orbital elements derived are as follows:

	Bright Com.	Faint Com.
Period, P	6.8292	
Eccentricity, e ..	0.25	
Time of periastron, T	1908 July 2.93	
Dist. node to periastron, ω	20°	200°
Semi-amplitude of vel. curve, K ..	126 km./sec.	166 km./sec.
Maximum velocity	+150 km./sec.	+120 km./sec.
Minimum velocity	—102 km./sec.	—211 km./sec.
Projected semi-axis major, $a \sin i$..	11,457,000 km.	15,094,000 km.
Ratio of masses .	1:0.91	
Velocity of system	—6.0 km./sec.	
Velocity of calcium	—16.4±0.6 km./sec.	

The velocity of the calcium differs by ten kilometers per second from that of the center of gravity of the binary system—a difference that seems too great to be explained by errors of measurement or of the assumed wave-lengths. Since a uniformly moving mass accompanying the system would be expected to have a velocity equal to that of the common center of gravity of the revolving stars, this investigation may be regarded as tending to support the hypothesis, favored by Slipher and others, of a detached calcium cloud in the line of sight.

There is some indication that the period is slowly lengthening. It is hoped that data derived from some older plates by Dr. Slipher may decide this point. This will also have a bearing on the question of the location of the calcium since, if the star is involved in a cloud of calcium or other substance, the friction should cause the period to shorten.

The Dissolution of Solar Prominences: FREDERICK SLOCUM.

Among the photographs of solar prominences at the Yerkes Observatory there are several series which show prominences in the act of dissolving. In general the prominences dissolve in one of the four following ways:

1. By floating up and dissipating like smoke from a fire.
2. By ascending and contracting into a long, fine filament.
3. By being torn into fragments and borne away as if by a strong wind.
4. By dissolving *in situ* like the trail of a meteor.

These processes were illustrated by lantern slides giving series of views of the prominences of June 19–20, 1911; September 19, 1911; July 25–29, 1908; March 25, 1910, and single views of other prominences.

All of the photographs were taken in the light of the H line of calcium with the Rumford spectroheliograph attached to the 40-inch telescope.

The Parallax of Nova Lacertæ 1910: FREDERICK SLOCUM.

Nova Lacertæ was discovered by Espin December 30, 1910. During the year 1911 ten photographs of the region around the Nova were made with the 40-inch telescope for the purpose of determining the parallax of the star. Cramer instantaneous isopleths were used in connection with a yellow color filter. In general two exposures were made on each plate. The exposure time was increased from 5 to 15 minutes as the star diminished from somewhat brighter than the 8th down to the 12th magnitude. Six comparison stars were selected as symmetrically situated as possible, and as near as possible to the mean brightness of the Nova. The parallactic displacement parallel to the ecliptic was measured. The value of the parallax came out +0".013 with a probable error of ±0".014. This would mean that the outburst observed in 1910 really occurred 250 years ago.

A Simple Pyrheliometer: W. J. HUMPHREYS.

This instrument consists essentially of a spherical Dewar bulb filled with mercury and provided with means for absorbing solar energy and measuring its effect.

A hollow platinum cone, polished on the inside, about seven centimeters long and with an opening one centimeter in diameter is symmetrically immersed in the mercury and set so that it will receive sunshine through a suitable system of diaphragms. Such a cone is well nigh a perfect absorber of radiation parallel to its axis, and as constructed the heat absorbed is rapidly transmitted to the mercury, the expansion of which is measured in a thermometer stem.

The readings consist in taking the time interval during the expansion of the mercury up the ther-

mmeter stem from one to another fixed point. Provision is made whereby, after one time interval has been obtained, the mercury can be set back below the first mark, and then another interval read, and so on as long as necessary.

The intensity of the insolation is inversely proportional, approximately, to the above time intervals—the times required for delivering substantially equal amounts of heat to the mercury.

While capable of development as a standard it was designed as a secondary instrument, the chief features of which are:

1. Essentially complete absorption of insolation.
2. Unchanging coefficient of absorption.
3. Highest possible heat insulation.
4. Freedom from calibration.
5. Ease of manipulation.

The Violle Actinometer as an Instrument of Precision: F. W. VERY.

The principal objects of this research are to show that the Violle actinometer may be used either dynamically or statically with equal precision, and to develop the theory of its static use.

Hitherto the rates of cooling of a thermometer in a partial vacuum have been used to get an estimate of losses by convection in an actinometer in air, but these measures have not differed essentially from the experiments of Dulong and Petit, and are quite inadequate, since they entirely neglect the losses by penetration of gaseous molecules. It is very commonly assumed that the velocity of cooling in "vacuum," obtained by Dulong and Petit,

$$V = k((1.0077)^{t+\theta} - (1.0077)^t),$$

represents a law of *radiation*; but this is not the case, since the observations included both radiation and penetration, and the latter is by no means insignificant.

By the use of Stefan's law for pure radiation, I first separated the radiant component, and from experiments by Langley and myself, and by Kundt and Warburg, I derived a preliminary value of the penetration in C.G.S. units,

$$P = 0.0001397 \theta.$$

This, however, did not represent the observations so closely as could be wished, and it was evident that dimensions and form of both radiating body and enclosure must enter into a complete theory. Taking Winkelmann's value of K (the constant of penetration for a plane surface in C.G.S. units), calling r the radius of the thermometer-bulb,

l the distance to the enclosing surface, and θ the temperature of excess, and reducing to minutes,

$$P = 4K\theta \times \frac{4\pi r^2}{l} \times 60.$$

With this formula the penetration was computed for two thermometers used by Langley on Mount Whitney in a Violle actinometer with the following result:

$\theta = 30^\circ \text{ C.}$, Green 4,572, cooling per minute by penetration, $-2^\circ.248$; observed, $-2^\circ.08$.

$\theta = 30^\circ \text{ C.}$, Baudin 8,737, cooling per minute by penetration, $-2^\circ.588$; observed, $-2^\circ.84$.

The convection loss can be represented by the formula

$$C = c \times \theta^{1.223} \times (p/p_1)^{0.45},$$

where

$$c = 0.000,005,02 + \frac{0.000,036,76}{r} \quad (\text{C.G.S.}),$$

a value determined by myself. p and p_1 are actual and normal barometric pressures, and the exponents are those of Dulong and Petit. For the given excess and Baudin thermometer,

Loss of temperature per minute by convection

$$= -4^\circ.158$$

Loss of temperature per minute by penetration

$$= -2^\circ.588$$

Loss of temperature per minute by radiation

$$= -2^\circ.890$$

Computed total loss $= -9^\circ.636$

Found $= -9^\circ.2$

The final difference of about $0^\circ.4$ includes errors of observation and also stem conduction which in this case was towards the bulb, or positive, the thermometer having been previously heated as a whole.

With some minor emendations relating to the general theory of the instrument, which can not be described here, I obtained from Keeler's observation with the Violle actinometer on the summit of Mt. Whitney:

Solar radiation at noon from initial rate of heating
 $= 1.995 \text{ cal. per sq. cm. per min.}$

Solar radiation at noon from static temperature
 $= 2.001 \text{ cal. per sq. cm. per min.}$

The difference in the results by the two methods is insignificant.

Improvements are suggested in the mounting and use of the instrument, and certain necessary precautions which have sometimes been neglected are described.

The Revised Draper Catalogue: ANNIE J. CANNON.

Owing to a general desire among astronomers for the class of spectrum of many more stars than have yet been studied, work has been begun upon a new catalogue of stellar spectra, to be called the Revised Draper Catalogue. The whole sky will be covered by photographs taken with a prism placed in front of the object glass of the 8-inch Draper and Bache telescopes, the exposure being generally one hour. It is believed that all stars of the eighth magnitude will be included, as well as many fainter ones. All the classification will be made by the writer, using the notation described in the *Harvard Annals*, volume 56, pages 66 to 69.

This work can be done rapidly, since previous study and classification of more than five thousand spectra taken with the various Harvard telescopes have made each division and subdivision a definite picture in the mind. Three assistants are working daily upon the laborious identifications, the reductions and the clerical part of the catalogue. Seven thousand spectra have already been classified, and it is estimated that if we have equally good photographs for the whole sky, the catalogue will contain one hundred thousand stars. It is proposed to print it in sections in the order of right ascension, of which the portion from 0^h to 6^h will form the first volume.

Notes on the Determination of the Elements of Algol Variables: H. N. RUSSELL.

Further study of this problem on which a report was made to the society in August, 1910, shows that, when there is no constant period at minimum (i. e., when the eclipse is partial), it is possible to represent the observed light curve within the error of ordinary observations by arbitrarily choosing any value within certain limits for the ratio of the radii of the two stars, and then determining the other elements in a suitable manner.

The various sets of elements, however, give different depths for the secondary minimum; and if this has been observed the problem becomes determinate, unless the primary and secondary minima are of nearly equal depth. In the latter case additional data (which can sometimes be supplied by spectrographic observation) are necessary if the elements are to be definitely determined.

Tables have been prepared which facilitate the numerical solution of these problems. With slight modifications, these may also be used in the case of variables of the Beta Lyrae type, in which the two stars are very close, and are distorted into prolate ellipsoids by their mutual attraction.

The Eclipsing Variables W Crucis and W Ursae Majoris: H. N. RUSSELL.

Good light-curves of these stars have been determined, the first at Harvard by Miss Leavitt, the second at Potsdam by Muller and Kempf and by Baldwin. Both are of the β -Lyrae type, and in each case the observations can be very satisfactorily represented on the eclipse theory.

W Crucis has a period of 198.5 days and a range from $8^m.9$ to $9^m.5$, with a secondary maximum of $9^m.2$. The system consists of two stars, one twice as bright and two and a half times as large as the other. The ratio of the longer and shorter axis of the ellipsoidal stars is 7:6. The relative orbit has an eccentricity of 0.04, and at periastron the surfaces of the two stars are separated by a distance slightly exceeding the diameter of the smaller. At principal maximum the smaller star is totally eclipsed by the larger. Increase and decrease of light lasting 14 days and totality 15 days.

The density of the larger star can not exceed $1/160$ that of the smaller star, $1/10$ that of the air under ordinary conditions. The spectrum is G pec. with bright lines.

This system is evidently in a very early stage of development, and if comparable with the sun in mass and surface brightness, must be at a distance of many thousand light-years.

The writer is greatly indebted to Professor Pickering and Miss Leavitt for unpublished observations of this star.

W Ursae Majoris varies from $7^m.9$ to $8^m.5$ in a period of 8 hours, within which there are two equal and equidistant maxima and minima. Its variations may be very satisfactorily represented on the assumption that the system consists of two stars, equal in size and brightness, with longer axes $4/3$ of the shorter axes, revolving in a circular orbit, and separated by only $2/5$ of their longer diameters. At maximum one star obscures half the disk of the other, the eclipse lasting one and a half hour.

The light-curve may be equally well represented with any ratio of the two radii between unity and 0.57—the surface brightness of the two stars being equal. The mean density of the system is 2.4 times the sun. This star is also of Spectrum G, but must represent a very different stage of evolution from the other.

The Solar Rotation: J. S. PLASKETT.

This paper gives an account of further work on the spectroscopic determination of the solar rota-

tion, a preliminary paper having been given at the last meeting. It includes a discussion of the measures of 110 spectra at seven different latitudes in the region $\lambda 5,500$ – $\lambda 5,700$ and of 24 spectra at the equator in the region $\lambda 4,200$ – $\lambda 4,300$. The value of the rotational velocity at the equator is at

$$\begin{aligned}\lambda 5,600, v + v_1 &= 2.021 \pm .003 \text{ km. } \xi = 14^\circ.35, \\ \lambda 4,250, v + v_1 &= 2.012 \pm .003 \text{ km. } \xi = 14^\circ.29,\end{aligned}$$

where $v + v_1$ is the linear and ξ the daily angular sidereal velocity. The law of equatorial acceleration or polar retardation follows the Faye form, having the following coefficients:

$$\begin{aligned}v + v_1 &= (1.306 + .701 \cos \phi) \cos \phi \\ &= 10^\circ.84 + 3^\circ.51 \cos^2 \phi.\end{aligned}$$

A comparison of ξ for different determinations gives

SunSpots	Faculae	Flocculi	Reversing Layer			
			Duner	Halm	Adams 1906-7	Plas- kett
14.40	14.62	14.55	14.81	14.53	14.63 1908 14.61	14.35

Whether the smaller value obtained here is due to some systematic error or to a variation in the rate of rotation there is as yet insufficient evidence to determine. It may be pointed out that the Ottawa observations were obtained at sun-spot minimum and the major part of the others more towards maximum.

A comparison of the residuals from lines of different elements in both regions indicates that any systematic deviations found, not greater except in one case than one third the average residual, are due to some personal systematic effect in measurement and not to differences of the rotational velocity in different elements.

The Moon's Mean Parallax: F. E. ROSS.

The following values of the lunar parallax and related quantities are based upon the constants of the geoid obtained in 1909 by the U. S. Coast and Geodetic Survey and upon Hinks's value of the moon's mass.

$$\begin{aligned}P_0 &= 3,422''.526 \pm 0''.012, \\ \Delta &= 238,857.9 \pm 1.1 \text{ U. S. statute miles,} \\ S &= 1,079.93 \pm 1.04 \text{ miles,} \\ D &= 0.6043 \pm .0003.\end{aligned}$$

P_0 is the constant of the sine parallax, Δ the mean distance, S the semi-diameter, and D the density

in terms of that of the earth. The correction to Hansen's parallax is

$$\delta H = + 0''.45.$$

Observations on the moon's limb for the determination of the parallax seem to be subject to large systematic errors. The results obtained by Olufsen, Henderson, Breen, Stone and Batterman lead to a value of 304 for the reciprocal of the earth's flattening. This systematic error seems to be largely eliminated in the recent Greenwich-Cape series of observations on the lunar crater Moesting A. The value of the reciprocal of the flattening resulting from this series is 294.45. It is likely that considerable further improvement in the results by the observational method would be obtained by the adoption of a photographic method.

The Secular Variations of the Elements of the Orbits of the Four Inner Planets: ERIC DOOLITTLE.

This paper presents the results of a computation extending over upward of sixteen years which had for its object a new determination of the perturbations of the orbits of the inner planets based on the most accurate elements now obtainable. The method employed differed from that of Le Verrier and Newcomb in that it depended upon the evolution of certain integral expressions instead of on the use of infinite series. Every possible device to insure accuracy was employed, the entire computation being duplicated and all known test equations applied. The well-known discrepancies which exist between certain of the variations as derived from theory and their values as determined from observation merely were fully confirmed. The figures expressing the motions of the perihelion of Mercury, the node of Venus, the perihelion of Mars and the eccentricity of Mercury, respectively, are as follows.

Newcomb	New Computation	Observation
+ 109''.76	+ 108''.91	+ 118''.24
— 106''.00	— 106''.00	— 105''.40
+ 148''.80	+ 148''.74	+ 149''.55
+ 4''.24	+ 4''.235	+ 3''.86

The Language of Meteorology: C. F. TALMAN. (Introduced by W. J. Humphreys.)

Scientific language is nowadays a somewhat neglected subject, and contemporary men of science show a reluctance to label their contributions to knowledge.

In meteorology there is need not only of new terms, but of a much more general use of the terms already introduced and adapted to their

purpose. A very large part of the meteorological vocabulary is unfamiliar to meteorologists. This is illustrated by the case of the "isograms." Upwards of eighty of these lines have been given appropriate names; but not a score of these names are in current use.

In no branch of science is the vocabulary more confused than in atmospheric optics; especially in English. One can hardly write of any but the commonest photometers without defining almost every term one uses. Thus the words "glory," "corona," "aureole" and "anthelion" are variously applied and interchanged; the Brocken specter is confused with the Brocken bow; etc.

Among meteorological neologisms the term "aerology," meaning the branch of science concerned with free-air investigations, deserves a wider use; "stratosphere" is the best name for the region of the atmosphere now more generally called the "isothermal layer"; Arctowski's terms "pleion" and "antipleion" are useful additions to the vocabulary; Dr. H. R. Mill's discrimination of "mean," "average" and "general" will obviate the confusion that heretofore reigned in the use of these words; the application now given in Great Britain to the terms "rime" and "glazed frost" is commended to general attention; L. Beson's name "nephometer" seems appropriate for an instrument used to measure the amount of cloudiness; the derivatives of the new German names for the snow-gauge ("chionometer," "nivometer") are likely to come into general use (*i. e.*, we shall use "nivometric," etc., though we may not adopt the noun); Odenbach's "cer-aunograph" is a good international name for the thunderstorm-recorder; the American name "kiosk" gives us a tolerable English equivalent for "Wettersäule."

An international commission on meteorological terminology is an urgent desideratum.

Can Astronomy Derive Benefit from the Dissemination of Esperanto? F. H. LOUP.

The paper first pointed out some of the easily verifiable indications of the entrance of Esperanto upon the stage of practical utility in the ordinary relationships of life, and proofs of the increasing popular acquaintance with it, especially in Europe; and then, passing to the consideration of its possible utilization in the service of astronomy, suggested its employment (1) in the oral discussions and the reports of international conventions, (2) in astronomical treatises, where, in the field of pure mathematics, for instance, such an example

has already been set as the work of Dr. Cyril Vörös, of Budapest, on "Absolute Geometry"—a book (including its three sections) of 439 pages, and of high scientific value, and (3) in the dissemination of astronomical news, through the *Internacia Science Asocio* and other channels, where, though the direct service were rather to the general public than to professional astronomers, yet the science would ultimately receive benefit.

On the Flexure of a Meridian Circle: W. S. EICHELBERGER and H. R. MORGAN.

From 1903 to 1911 the flexure of the 9-inch transit circle of the Naval Observatory was determined from measures on collimators. The circle was shifted for each of the six clamp years, and at the end of the work, and the circle flexure distinguished from the tube flexure.

The table gives the division of the circle at the object glass end, the means of the measures on the collimators for each position, and the residuals from the solution of the fourteen equations.

The first eight equations result from 70 sets of measures on the horizontal collimators, and the last six from 68 sets of measures on the vertical collimator and nadir.

	<i>O</i>	<i>Wt</i>	<i>O—C</i>
$x_s + y \cos(A - 270^\circ 4')$	$= -0''.95$	3	$+0''.11$
$x_s + y \cos(A - 269^\circ 56')$	$= -1''.14$	6	$-0''.08$
$x_s + y \cos(A - 264^\circ 52')$	$= -1''.02$	6	$-0''.04$
$x_s + y \cos(A - 259^\circ 40')$	$= -0''.74$	13	$+0''.16$
$x_s + y \cos(A - 256^\circ 28')$	$= -0''.99$	18	$-0''.15$
$x_s + y \cos(A - 261^\circ 34')$	$= -0''.89$	6	$+0''.04$
$x_s + y \cos(A - 261^\circ 16')$	$= -0''.85$	9	$+0''.07$
$x_s + y \cos(A - 81^\circ 16')$	$= +0''.35$	9	$0''.00$
$x_c - y \sin(A - 264^\circ 52')$	$= +1''.08$	10	$+0''.12$
$x_c - y \sin(A - 259^\circ 40')$	$= +0''.85$	14	$+0''.17$
$x_c - y \sin(A - 256^\circ 28')$	$= +1''.13$	12	$+0''.08$
$x_c - y \sin(A - 261^\circ 34')$	$= +1''.07$	14	$+0''.07$
$x_c - y \sin(A - 261^\circ 16')$	$= +0''.93$	9	$+0''.07$
$x_c - y \sin(A - 81^\circ 16')$	$= -0''.96$	9	$-0''.03$

The solution gave: the coefficient of the sine flexure of the tube, $x_s = -0''.289$; the coefficient of the cosine flexure of the tube, $x_c = +0''.037$; the coefficient of the flexure of the circle, $y = +1''.156$; the point of maximum weight of the circle, $A = 137^\circ 55'$. To test the sine law, 264 direct and reflected star observations were taken, on both clamps, and both sides of the zenith. The solutions in the table give the error of the nadir, or cosine flexure; a term for bisection error, or other discontinuity at the zenith; and the sine flexure.

Clap No. Nights	$\frac{1}{2}(R-D)$	Mean Residual
E 5	$-0''.71 \pm 0''.34 - 1''.14 \sin z$	$\pm 0''.19$
W 2	$-1''.11 \pm 0''.34 - 1''.11 \sin z$	$\pm 0''.15$
W 4	$-1''.01 \pm 0''.83 - 1''.11 \sin z$	$\pm 0''.15$
W 2	$-1''.60 \pm 0''.40 - 1''.11 \sin z$	$\pm 0''.17$
W 2	$-1''.48 \pm 0''.28 - 0''.58 \sin z$	$\pm 0''.16$
W 2	$-1''.07 \pm 0''.71 - 1''.37 \sin z$	$\pm 0''.18$
E 2	$-0''.81 \pm 0''.22 - 0''.77 \sin z$	$\pm 0''.28$

The agreement with the collimator measures is satisfactory. To test the cosine law, 20,000 star observations, corrected for division error, bisection error, variation of latitude and flexure, were differenced for successive clamp years. The mean values of ($S_{10} - S_2$) are:

$$-0''.24, -0''.23, -0''.23, -0''.03, -0''.11.$$

The residuals from these means were solved in the form

$$0''.04 \cos z - 0''.11 \cos 2z.$$

This reduced the mean residual from $0''.09$ to $0''.08$, only, and has not been used. The mean differences ($S_{10} - S_2$) were attributed to the uncertainty in the various nadir division errors. The corrections, following, were, therefore, applied to the different years; their sum is zero:

$$+0''.17, -0''.07, +0''.16, -0''.07, -0''.04, -0''.15.$$

Tests with Standard Electric Lamps: E. S. KING.

These tests relate to two lamps, rated for 2-candle power, loaned from the Bureau of Standards at Washington. In comparing these lamps with the Argand Standard, I have included 6 commercial lamps, which were regulated to approximately the same intensity. The results for 8 comparisons, made at intervals of about a day, show great constancy. The average deviation in magnitudes for Lamp No. 1 is ± 0.035 , for Lamp No. 2 ± 0.031 , for the mean of the 6 commercial lamps, ± 0.030 and for the mean of all the lamps ± 0.025 .

Comparisons with ten different stars were made by the out-of-focus method with the 11-inch Draper telescope on seven different nights. The resulting photographic magnitudes for the lamps at a distance of 1 meter are as follows: Lamp No. 1, 12.02; Lamp No. 2, 12.10; Lamp No. 8, 12.01. From the comparisons with the Argand the results are, Lamp No. 1, 12.05; Lamp No. 2, 12.12; Lamp No. 8, 12.04. These figures indicate that the lamps must be placed at a distance of about a kilometer to have the same photographic brightness as Polaris.

Recent Interviews with Optical Glass Manufacturers of France and Germany: J. A. BRASHEAR.
Some Observations with the 60-inch Reflecting

Telescope of the Mt. Wilson Solar Observatory:
E. E. BARNARD.

Photographic Observations of Brook's Comet 1911: E. E. BARNARD.

This comet when found by Brooks was a faint object without any tail. A long exposure photograph a few days after its discovery showed only a round diffused object with no signs of a tail. Later the comet developed a tail, and became visible to the naked eye and presented a splendid spectacle in the evening and then in the morning sky. Its naked eye visibility was of long duration, from August to December.

Though it developed a slender tail early in its career it was very disappointing, for photographs made night after night did not show any changes worth mentioning and the comet promised to be of little interest from a photographic standpoint. The photographs on different nights simply repeated themselves. In October, however, there was apparently a complete transformation of its nature and it really became one of the most interesting comets yet photographed. From the previous condition of a steady outflow of matter which marked its appearance until October the tail now presented a very active and remarkable appearance changing from day to day from one complex and beautiful form to another equally remarkable. The photographic activity was also greatly increased, much more, apparently, than its increase of light would account for. The phenomena of Morehouse's comet were duplicated in almost every particular. This change in the nature of Brook's comet did not seem to be due to any special change in its spectrum. Cyanogen did not appear at any time in the spectrum of the tail, though it was present in the head. This compound which was such a striking feature of the spectrum of the tail of Morehouse's comet was supposed to be the cause of the remarkable phenomena of that comet. Its absence from the tail of Brook's comet would seem to show that after all it was not necessarily the cause of the freakish nature of that comet.

Personal Equation Apparatus for Nine-inch Transit Circle, Naval Observatory: F. B. LITTELL.

The new personal equation apparatus recently installed is based on the same principle as that devised by Professor John R. Eastman, U.S.N., but differs entirely in details and secures a much more exact reproduction of the circumstances of actual observation and more extended application.

An artificial star moves alternately east and west across the line of sight at the focus of the

north meridian mark, a small electric motor furnishing the motive power. The speed can be varied to represent that of any star from 0° to 89° of declination. The apparent magnitude of the star may be varied by interposing screens in the line of sight, or by changing the resistance in the electric-light circuit.

This star will be observed by the use of the transit circle, just as an actual star would be observed, the movement of the carriage carrying the star in the meantime causing a similar automatic record to be registered on the chronograph. A complete observation includes the observation of the star during its east and west movement, using a reversing prism at the eyepiece to keep the apparent direction the same. By comparing the observer's record of such an observation with the automatic record, his absolute personal equation can be determined, and by suitable series of observations, the personal equations of various observers dependent on velocity and direction of motion, or magnitudes of stars, and for such objects as the limbs of the sun, moon, etc., may be determined.

At present nearly all star catalogues are more or less affected by such errors. Even if a self-registering right ascension micrometer and a reversing prism are used, by which many errors are greatly reduced, it is still desirable that observers should determine them, and if necessary apply corrections for them.

Measures of the Satellite of Neptune, and of Oberon and Titania, Satellites of Uranus, made at the Naval Observatory, 1908-10: ASAHI HALL.

After the publication, in 1875 and 1885, of the measures made at the Naval Observatory of the satellite of Neptune, Mr. Marth pointed out the curious motions of N and I , which determine the position of the satellite's orbit plane with reference to the equator. It has been explained that these motions might be produced by a flattening of the planet which causes the pole of the plane of the satellite's orbit to describe uniformly a small circle about the pole of the planet.

Therefore, for the purpose of following these motions, the satellite of Neptune has been measured at the Naval Observatory during many oppositions.

For the two oppositions 1908-09 and 1909-10, the following corrections have been obtained to the data of the *Connaissance des Temps*, which are the elements of H. Struve published in 1894:

1908-09	1909-10
$du = +1^\circ.223 \pm 0^\circ.190$	$du = +0^\circ.521 \pm 0^\circ.162$
$dN = +1.341 \pm 0.383$	$dN = +1.097 \pm 0.313$
$dI = +0.401 \pm 0.376$	$dI = -0.277 \pm 0.294$
$Q = 179^\circ.51$	$Q = 37^\circ.34$
$e = 0.002,71$	$e = 0.009,60$
$da = +0^\circ.344 \pm 0^\circ.056$	$da = +0^\circ.058 \pm 0^\circ.045$

The corrections to u , N and I are believed to be real. Evidently there is a considerable change of personal equation in the distance pointings, as has been shown already in the measures of several observers.

The measures of Neptune's satellite made some years ago at the Yerkes Observatory by Professor Barnard with the 40-inch refractor, give for the semi-major axis of the orbit at the mean distance of the planet from the sun, $16''.22$, instead of $16''.27$, which is usually accepted.

On account of the large aperture of the telescope employed, this determination appears to be the most accurate of the visual measures, and least liable to systematic errors.

Various experiments have been made at the Naval Observatory with reference to the elimination of systematic errors, including the use of reversing prisms. However, with the prisms employed, so much light is lost that they can be used only on very good nights.

For Oberon and Titania, satellites of Uranus, the following corrections have been obtained to the elements of the *Connaissance des Temps* from observations made at the oppositions of 1908, 1909, 1910:

Oberon	Titania
$du = +0^\circ.767 \pm 0^\circ.207$	$du = +1^\circ.340 \pm 0^\circ.262$
$dN = -0.077 \pm 0.360$	$dN = -0.634 \pm 0.474$
$dI = -0.611 \pm 0.347$	$dI = -0.730 \pm 0.412$
$Q = 218^\circ.41$	$Q = 216^\circ.45$
$e = 0.0100$	$e = 0.0934$
$da = +0^\circ.167 \pm 0^\circ.119$	$da = +0^\circ.139 \pm 0^\circ.090$

From measures secured in 1911 by Mr. Eppes and Mr. Burton, Mr. Eppes has found the following corrections to the data of the *Connaissance des Temps*:

Oberon	Titania
$du = +0^\circ.735 \pm 0^\circ.179$	$du = +1^\circ.778 \pm 0^\circ.159$
$dN = -0.263 \pm 0.261$	$dN = -0.253 \pm 0.295$
$dI = +0.221 \pm 0.235$	$dI = +0.033 \pm 0.271$
$Q = 60^\circ.06$	$Q = 285^\circ.02$
$e = 0.00214$	$e = 0.00180$
$da = +0^\circ.072 \pm 0^\circ.074$	$da = +0^\circ.208 \pm 0^\circ.075$

The Paris Conference of October, 1911: W. S. EICHELEBERGER.

At the recent conference of the directors of the several national nautical almanacs held in Paris in October, 1911, cooperation among the respective offices was recommended to their several governments. A full account of the work of the conference is contained in the *Astronomische Nachrichten*, No. 4535, for November 12, and in *Nature* for November 30.

Attention was called particularly to three of the resolutions adopted by the conference.

1. The conference strongly recommends that the ephemerides of the stars, that is to say, their correction from mean to apparent place, should be calculated for the upper transit at the meridian of Greenwich.

2. The conference is of the opinion that the adoption of the meridian of Greenwich for all ephemerides should be realized as soon as possible.

3. The ordinary ephemerides of the stars shall be calculated to $0^{\circ}.001$ in right ascension so far as 60° of declination and $0^{\circ}.01$ in declination.

The first two resolutions quoted imply that each office in computing results which are to be furnished the other almanacs will do so for the Greenwich meridian. The question naturally arises with reference to the *American Ephemeris*, for instance:

1. Should the ephemerides for the physical observations of the sun, moon and planets and the ephemerides of the satellites of Mars, Uranus and Neptune which will be computed by the office of the *American Ephemeris* for Greenwich mean noon and in that form furnished to the other almanacs, be printed in our almanac for Greenwich mean noon, or is there sufficient reason to require us to make the necessary additional computations to enable us to publish these data for Washington mean noon as at present?

2. Should the apparent places of the stars which will be furnished to the office of the *American Ephemeris* by the European almanac offices for superior passage over the meridian of Greenwich be published in our almanac for transit at Greenwich or transformed to transit at Washington as at present?

3. Is it to the advantage of astronomers in general to have the apparent places of stars given to $0^{\circ}.001$ in R.A. so far as 60° of declination and $0^{\circ}.01$ in declination?

It is not intended to increase the labor of computing to obtain the additional decimal, but simply

to publish the additional decimal which is at present always computed in the various almanac offices. Nor is it intended that this last decimal shall be accurate to within a unit. In fact it may be in error several units. The object in publishing the additional decimal is to permit any one to interpolate to the time of observation, the apparent place as given; to apply the short period terms for whose calculation convenient tables will be provided; and finally to obtain his computed right ascension at the time of observation accurately to the hundredth of a second of time and his declination to the tenth of a second of arc.

It is upon these questions that the Naval Observatory would like to have an expression of opinion from the astronomers of the country.

The Spectrum and Orbit of β Scorpii: Z. DANIEL and F. SCHLESINGER.

This is one of the spectroscopic binaries (discovered by Slipher at the Lowell Observatory) for which the H and K lines, due to calcium, appear to be nearly or quite stationary. Only two of these objects have thus far been studied: δ -Orionis by Hartmann and α -Persei by Jordan. From 73 spectrograms secured in 1911 with the Mellon spectrograph of the Allegheny Observatory, the following elements have been derived by means of a least-squares solution.

$$\begin{aligned} P &= 6.8283 \text{ days} \pm 0.0001 \text{ day,} \\ K &= 125.66 \text{ km.} \pm 1.18 \text{ km.,} \\ e &= 0.270 \pm 0.008, \\ T &= \text{J.D. } 2419163.923 \text{ G.M.T.} \pm 0.034 \text{ day,} \\ \omega &= +20^{\circ}.1 \pm 2^{\circ}.2, \\ \gamma &= -11.0 \text{ km.} \end{aligned}$$

Measurements of the secondary spectrum could also be made on some plates, and these yield

$$\begin{aligned} K_s &= 197 \text{ km.} \pm 10.5 \text{ km.,} \\ m \cdot \sin^3 i &= 13.0, \\ m_s \cdot \sin^3 i &= 8.3, \end{aligned}$$

the unit of mass being that of the sun. Using Rowland's wave-length for the K-line, the mean velocity derived from it is $-8.6 \text{ km.} \pm 1.7 \text{ km.}$, which is not far from that of the center of mass of the system, a result in accord with those for δ Orionis and α Persei.

Report of the Committee on Comets, December, 1911: G. C. COMSTOCK (chairman).

Owing to the absence of its chairman abroad during a major portion of the past year the work of the committee on comets has consisted mainly

in the accumulation and tabulation of replies to its circular letter relative to photographs of Halley's comet. From these replies there has been constructed a card catalogue exhibiting in chronological order the material available for a photographic history of this comet during its appearance of 1910. At present this catalogue consists of about a thousand titles, but it can not be regarded as complete, owing to the absence of reports from several important sources.

Correspondence is being conducted in the endeavor to supply as far as may be the missing data, but it is already apparent that the existing gaps can not be completely filled. A period of very great activity in photographing the comet accompanies the date of its nearest approach to the earth, but this is preceded by an epoch of comparative neglect and is followed, in July, 1910, by an apparently complete cessation of photographic work upon the comet, continuing until December, when some exposures were made at the Lick Observatory and reported to the committee. It is earnestly hoped that these lacunæ will be filled by observations not yet reported to the committee.

As soon as the card catalogue can be regarded as reasonably complete it is the purpose of your committee to select from it such data for reproduction as will best serve its purpose of constructing a graphic history of the comet's appearance in the years 1909-10.

Report of the Committee on Photographic Astrometry: F. SCHLESINGER (chairman).

The chairman reported briefly on the progress made since the meeting at Ottawa four months earlier, at which a full report had been read. It appears that the most immediate duty of this committee is to study the movements of a pier during the course of a night, and if possible to devise some method by which a pier can be kept stationary within small amounts. For this purpose a 10-inch photographic telescope of 100 inches focal length has been constructed, and is now being mounted upon a pier at the Allegheny Observatory. The pier and telescope are to be kept at a nearly constant temperature in a basement room at the observatory. At frequent intervals throughout the night, short exposures are to be made upon the region of the pole, access to this part of the sky being obtained through a window of plane parallel glass. Dr. Schlesinger also referred briefly to the progress made by Dr. Ross with the photographic zenith-tube designed by the latter and mounted by

him at the International Latitude Station at Gaithersburg. The material thus far secured indicates a considerable reduction in accidental errors, as compared with the best work of the zenith telescope by Talcott's method. This instrument had been in operation during a few months only, and consequently no information is as yet forthcoming as to the freedom of the method from systematic error.

A verbal report by Professor C. L. Doolittle, chairman of the committee on cooperation in the teaching of astronomy, was followed by an extended and profitable discussion.

Late in the afternoon of Friday, December 29, the society adjourned to reassemble at the Allegheny Observatory, Pittsburgh, in the following August.

R. H. CURTISS,
Editor for the Meeting

ANN ARBOR,
February, 1912

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

THE meeting of the Academy of Science of St. Louis was held at the Academy building on Monday, March 18, 1912, at 8 P.M., President Engler in the chair.

Professor C. A. Waldo, of Washington University, addressed the academy on "The Problems of Coal Exhaustion."

"Miniature Flint Arrows" was the subject of a short paper by Dr. H. M. Whelpley, who illustrated his remarks with over 2,000 specimens, varying in length from .06 to 1 inch. In form they represent all of the common types of ordinary arrows and were evidently made by the same process of pressure chipping. Specimens have been found in England, Spain, Belgium, India, Palestine, Egypt and the United States. These artifacts belong to the Neolithic age. It has been suggested, but without evidence, that they were made by a pygmy race of human beings. It is also claimed that they were barbs for harpoons, tattooing instruments, fish snags or drills for skin and shell work. Dr. Whelpley concludes that the medium size and larger miniature arrows, such as are very plentiful along portions of the Missouri and Meramec Rivers, were used as arrow heads. The most minute ones he considers examples of skill in flint chipping, the same as the miniature baskets made by the Pomo Indians to-day are merely examples of skill in basketry.

Dr. R. J. Terry reported on "A Grove of Deformed Trees."

A grove of four or five hundred small per-simmon trees in St. Louis County has suffered from the ravages of a beetle which has been identified as *Oncideres cingulata*. Limbs varying in diameter from 5 to 15 mm. are girdled and the ends fall to the ground. All the trees, old and young, have been attacked. The girdling is done in the fall, mainly in September and October. During this time the larger trees present scores of branches bearing dead leaves and the ground is strewn with fallen branches often laden with fruit. There is no tree in the grove that does not present crooked trunk and limbs. The deformities in some cases are extreme. Most of the trees are as a consequence dwarfed, although able to make some advance in growth. Some trees only a meter and half tall bore fruit in 1911.

A few beetles have been observed working. The cut was begun on the upper side of the branch and was made 3-4 mm. wide and about 3 mm. deep. Most of the limbs fall, probably within a few days after the girdling. A small proportion remain throughout the following winter. On every severed branch, near the distal ends of the twigs, one or more small deep excoriations of the bark were found. That the beetle makes similar abrasions of the bark of twigs of the honey locust is known from observation on *Oncideres* in captivity. Limbs recovered from the ground in winter in some cases presented no evidence of the propagation of the beetle, whereas in others more or less of the wood had been destroyed under the bark along one side of the branch extending from the distal end proximally. The cavity never quite reached the proximal severed end. Larvæ which are now being studied were discovered in some of the tunnels.

At the meeting of the Academy of Science of St. Louis, held at the Academy building, March 4, 1912, Dr. Charles A. Todd addressed the academy on "A Problematical Geological Phenomenon in Colorado."

In the Estes Park district of Colorado there is a remarkable collection or aggregation of rocks, the exact nature of which at present is undetermined. This geological puzzle is in the form of an oblong pit with sides sloping at an angle of 45° and meeting at the bottom. Its length is 600 feet; width, 200; depth, 50. These measurements are only estimates. At the eastern extremity of this oblong is a circular pit 150 feet in diameter.

Both pits have the same general characteristics. Their walls are of more or less cubical masses of country granite, sharp angled and solidly jammed together for the most part. The largest blocks are on the upper part of the wall; one I judged to be 30 × 40 feet with irregular thickness. These pits are in the valley of Fern Lake on a branch of the Thompson River and about three miles from the Continental Divide. They are on the right-hand side of Fern Lake, forming part of the shore. All this district has been subject to glacial action and this valley gives all indication of having been plowed out by the ice. Fern Lake is a circular glacial lakelet about one fourth of a mile in diameter and said to be 75 feet deep. Its shores drop off abruptly with the depths. Just above the lake is a bench extending two miles up stream to another and larger glacial lake. At the lower end of Fern Lake is a terminal moraine, filling the valley (which is here about three fourths of a mile wide) and extending down stream two miles, where the main Thompson flows through a rather wide cañon. The question is, how came these rocks here and so arranged. Two theories are advanced: One is that the pits represent a "blow-out." In that case the applied force must have been gaseous, since there is no lava or ash in the neighborhood. The second theory is that the rocks are glacial deposit. They are, as stated, in the course of the ice stream and next an extensive moraine. But the peculiar configuration of the pits, the sharp angles of the cubical fragments, etc., seem to oppose this view. The surest way to settle the matter evidently would be to sink a shaft in the bottom of the main pit and determine whether or not the broken rock extends well below the general level of the valley at that point.

Dr. H. T. A. Hus, of the University of Michigan, read a paper on "Inheritance in *Capsella*."

Professor Nipher made a verbal communication concerning some of his more recent work on the nature of the electric discharge. Former results of his work seem to point very strongly to the one-fluid theory. It would follow that the two waves which were shown to exist in the Wheatstone experiment were compression and rarefaction waves. The negative wave is in the nature of a super-charge which travels along on the outer surface of a thin outer film of the conductor. The positive wave is one in which a thin outer film of the wave is suddenly drained of the negative charge, at the instant of passing of the wave. We had been led to suspect as a result of recent experiments that

matter in this latter condition is explosive. The tests have been made on thin fuse wires sealed into long glass tubes through which the wire passes. The wires were sealed in by means of hard sealing wax. A discharge from a battery of Leyden jars was passed through the wires. The disintegration of the wires is much greatest at the positive end. The sealing wax, wire and glass tube in almost every case, break down at that end. The lead is dispersed in a fine powder or dust.

Professor Nipher remarked that he had just found in the London *Phil. Mag.*, Vol. 46, of 1815, pp. 161 and 259, an account of the work of De Nelis and Singer, who passed a positive discharge through a lead wire of 0.01 inch diameter contained in an iron tube. The wall of the tube was usually about 0.14 inch in thickness. In one case the tube was one inch in external diameter, with a small bore admitting a steel needle with wax insulation and terminating in the short lead wire resting on the bottom. The lead wire was surrounded by oil. Such tubes were burst by repeated explosions of the lead wire, which required to be replaced at each discharge. The discharge was from a battery of Leyden jars having an area of from 75 to 100 square feet. The needle and part of the liquid were thrown out at each explosion. In some cases the liquid was thrown to a height of 40 feet. The experimenters do not seem to have used the negative discharge. They attributed the effects to the expansive power of the electric fluid.

What they were doing was to suddenly drain that lead wire of the negative fluid. The atoms of lead then repel each other. Some of the effect is of course a heat effect. The question arises, however, will the negative discharge produce a like or an equal effect? Is it not possible that such molecular repulsion is primarily concerned in the formation of disruptive channels in air and resulting in spark discharges and lightning?

GEORGE T. MOORE,
Corresponding Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE 79th regular meeting of the society was held at the Shoreham Hotel, Tuesday, March 5, 1912, at 8 o'clock P.M. President W. A. Orton presided. This being the annual open meeting the program was devoted to an address on "The Present Status of the Genetics Problem," by the retiring president, Professor W. J. Spillman. The address will appear in SCIENCE.

THE 80th regular meeting was held at the Cosmos Club, Tuesday, April 2, 1912, at 8 o'clock P.M. President W. A. Orton presided. Eighteen members were present. Dr. Errett Wallace and Messrs. L. H. Evans, S. M. McMurran and S. C. Stuntz were admitted to membership.

The following papers were read:

Studies on European Herbaria with Special Reference to Preservation of Type Specimens: WALTER T. SWINGLE.

The speaker on recent visits to the principal European herbaria was impressed by their lack of the geographic limitations, so common in American herbaria. However, the management is much the same as it was a century ago. There is no adequate correlation of the seed and fruit collections with the plants in the herbaria. Alcoholic specimens scarcely exist, and such as are found are neither well indexed nor referred to on the specimen sheets.

The method generally followed at present of leaving types along with the other specimens is certain to lead to their rapid deterioration and ultimate loss. Provision should be made for saving fragments which may drop from the specimen and to this end it was suggested that a sheet of transparent paper be pasted to the back of the herbarium sheet, bending over it, thereby protecting the specimen. Smaller types and fragments of types can be preserved in pasteboard boxes with a glass top, the specimens being pressed against the glass by layers of cotton batting.

It is important to recognize that in plants type specimens can often be indefinitely multiplied by cutting branches from the same plant, or by securing flowers or fruits from the same plant during successive years. These types which are secured from the same plant individual are termed *merotypes*.

The Celebration of the One Hundredth Anniversary of the Academy of Natural Sciences of Philadelphia: W. E. SAFFORD.

Mr. Safford, the delegate of the Botanical Society at the academy's centenary celebration, gave a graphic and comprehensive report of the meetings and made special mention of the papers of botanical interest there presented. The speaker also gave an account of the development and resources of the academy's herbarium.

W. W. STOCKBERGER,
Corresponding Secretary

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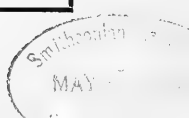
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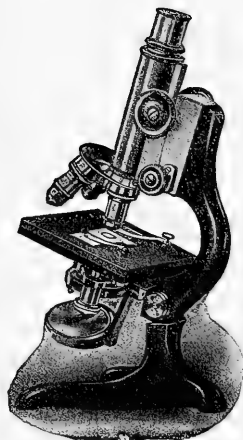
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THE FUNGUS OF THE CHESTNUT-TREE BLIGHT¹

THE disease of chestnut trees now causing serious injury in the eastern states was first noticed about the year 1904 in the vicinity of New York and is believed to be due to the growth of a hitherto unknown fungus described by Murrill in 1906 under the name of *Diaporthe parasitica*. The question naturally arises: Is the *Diaporthe* a native species of this country which had escaped the observation of mycologists, or is it an introduced exotic species? If it is a native species we must next ask how it happens that so severe an epidemic has appeared suddenly, for, if the fungus has always existed here, the important practical question is: What temporary conditions have arisen which have enabled it to increase at a rate previously unknown? Although there are some vague references to diseased chestnut trees in agricultural journals published a good many years ago, there is nothing in them to warrant us in believing that a disease at all comparable with the present chestnut epidemic ever prevailed here. One thing, at least, is certain. Had there been within the last fifty or sixty years a disease of chestnuts in the region now devastated similar to the present epidemic, there would have been left no large trees to be attacked now.

In general it may be said that when a disease due to a fungus appears suddenly and with great severity, the chances are that it is owing to the introduction of some exotic species which, although it may not

¹ Paper read April 19, 1912, before the American Philosophical Society, Philadelphia.

cause serious trouble in the country from which it came, is able to produce disastrous effects on our native species which have not through long exposure become more or less immune to the fungus. It has been suggested that the chestnut-tree fungus was introduced from Japan. The arguments advanced by those who adopt this view do not seem to me to be at all conclusive. That the *Diaporthe parasitica* is a native of Japan remains to be proved. Furthermore, we have no accounts of any disease of chestnuts in Japan similar to our present disease. If I am not mistaken, the main reason for thinking that the disease might have come from Japan was the statement which had been made that Japanese chestnuts grown in this country did not contract the disease. That they are really immune is, to say the least, very doubtful, and is positively denied by some experimenters.

The first fruiting specimens of the chestnut-blight fungus which I was able to examine struck me as having a close resemblance externally to what is generally known in American herbaria as *Endothia gyrosa* and also to a specimen issued in an Italian series of fungi exsiccati. With regard to the North American specimens of *Endothia* I shall speak later. The Italian specimen to which I refer is No. 986 of the first series of the *Erbario Crittogamico Italiano* issued in 1863. The label states that the fungus grew on chestnut trunks at Locarno on Lake Maggiore, where it was collected by Daldini in 1862. The name there given is *Endothia radicalis*, on which more needs to be said in connection with American specimens. The Italian specimen referred to has ascospores which seem to me to be the same as those of American specimens of *Diaporthe parasitica*, and my opinion is shared by some other mycologists who have examined the specimens in

question. Of European botanists who have expressed the opinion that *Diaporthe parasitica* and *Endothia gyrosa* are identical may be mentioned Von Höhnelt and Saccardo.

But the Italian fungus, by whatever name we call it, is not known to cause a disease of chestnuts in Italy, where, in consequence of the commercial value of the chestnut, the fungi which attack it have been carefully studied. Several diseases of chestnuts, due to fungi, are known in Italy, but the fungi which cause them are not any form of *Endothia*. In spite of the fact that the *Endothia* does not cause a recognized disease in Italy, it is conceivable that, if introduced into this country, it might cause serious damage to American species of chestnuts, since they have not by long exposure to the fungus become immune.

In this connection it should be stated that the Italian chestnut trees cultivated in this country are said to be attacked and destroyed by *Diaporthe parasitica* as well as our native species of chestnuts. We have also some recent experiments of Pantanelli, who in the *Rendiconti Accademia dei Lincei* of 1911 gave an account of inoculations made at Rome with spores of *Diaporthe parasitica* received from America. He made three sets of experiments. In one he inoculated sterilized dead branches of the Italian chestnut; in another living branches kept in closed cultures, and in the third he inoculated small chestnut trees placed in dishes in his laboratory. From the first two series of experiments, although the spores of the American material germinated, and developed a mycelium and conidia, we can infer only that the fungus in closed cultures may be made to grow as a saprophyte on the Italian chestnut, but we can infer nothing as to its parasitic action. In the third series of

experiments Pantanelli inoculated sixteen plants. Of these seven dried up, whether from the action of the fungus or from some other cause is not quite clear. From the other cases Pantanelli concludes that the American fungus may cause serious damage to Italian as well as American chestnuts. No control plants appear to have been used. To obtain a clear idea of the action of the fungus a more detailed account is to be desired.

Pantanelli compares the American *Diaporthe parasitica* with the five other species of *Diaporthe* which have been recorded on chestnuts and he considers it different from any of them, in which opinion he is correct. The important point, however, is not to distinguish between *Diaporthe parasitica* and the other five species of that genus, but between *Diaporthe parasitica* of America and *Endothia radicales* of northern Italy, to which it is evidently more closely related than to any of the other *Diaporthe* species. It is also to be desired that series of experiments with the inoculation of the spores of the Italian *Endothia* on Italian and American species of chestnut be made.

Before proceeding farther let me recapitulate what has already been said. First, our chestnut-blight fungus, if an imported species, is not likely to have come from Japan. Secondly, a fungus noticed on chestnuts in Italy as long ago as 1862 in external appearance and the microscopic characters of the perithecia, asci and spores so closely resembles the American chestnut fungus that they have been considered identical by some well-known European botanists. Thirdly, the American fungus is believed to be the cause of a very serious disease of American chestnuts and also to attack Italian chestnuts grown in America, while, on the other hand, the Italian fungus does not produce any clearly recognized disease.

If we now turn to the question whether the fungus of the present chestnut blight can be considered identical with any species previously known in America, we find ourselves involved in a maze of conflicting descriptive and bibliographical details which must utterly confuse those who are not expert mycological systematists, and even experts may be pardoned if they hesitate to express a very decided opinion on the subject. Although it can not be expected that any but specialists would be interested in the study of the very scattered literature relating to the subject, it may be of interest to others to have a general statement as to why it is so confusing even to experts.

As has been said, the name on the label of the specimen in the Erbario Crittogamico Italiano is *Endothia radicalis*, which to mycologists signifies that the Italian botanists, Cesati and De Notaris, to whom the naming of the specimen is to be attributed, were of the opinion that the Italian fungus was not a new species, but was identical with *Sphaeria radicalis* of Schweinitz described in his "North American Fungi" in 1832, which they erroneously quote as the species on which Fries founded the genus *Endothia* in 1849. The genus was really founded on *Sphaeria gyrosa* of Schweinitz from North Carolina, described still earlier, in 1822. Subsequent writers, however, considered *S. gyrosa* and *S. radicalis* as the same species to which the earlier specific name *gyrosa* should be given. Besides the specimen issued in the *Erbario Crittogamico* other Italian specimens were distributed in Rabenhorst's "Herbarium Mycologicum," Thuemen's "Mycotheca Universalis" and Saccardo's "Mycotheca Veneta," and as early as 1829, only seven years after Schweinitz's original description, *Sphaeria gyrosa* was reported in Italy by Rudolphi in *Linnaea*.

Since 1829 there have been numerous references to the same fungus occurring in other European countries. In 1830 Fries stated in *Linnea* that it had been found in France, and Tulasne in his "Carpologia," 1863, refers in detail to French specimens. In 1870 Fuckel and in 1886 Winter referred to its occurrence in Germany and specimens were distributed by Roumeguère in "Fungi Gallici" and Portuguese specimens in "Fungi Lusitanici." In the recent "Flora Italica Cryptogama," 1906, the species is said by Traverso to occur in still more remote regions. If we are to trust the writers above mentioned *Endothia gyrosa*, originally described from North Carolina, is a species which is widely scattered through the northern hemisphere. It is generally said to grow on dead wood and in no cases is there any mention of a serious disease of the trees attacked. The hosts mentioned are, besides *Castanea*, *Æsculus*, *Alnus*, *Carpinus*, *Corylus*, *Fagus*, *Juglans* and *Quercus*.

Although, assuming that *Endothia gyrosa* and *Endothia radicalis* are only different names for a single species, all the European mycologists mentioned agree in believing that their *Endothia* on chestnuts is identical with the *Endothia gyrosa* of North America, we must ask ourselves whether their opinion is correct. This brings us to the main question, or rather conundrum: What is *Endothia gyrosa*? If we could answer that question most of the systematic difficulties which perplex us would disappear. Unfortunately, it seems to be almost impossible to be sure of what Schweinitz included under his *Sphæria gyrosa*. Specimens are in the Schweinitzian Herbarium in the Academy of Natural Sciences in Philadelphia, and other specimens of Schweinitz are to be found in a number of other herbaria in this country and Europe. Through the kindness of

Professor Stewardson Brown I have been able to examine the specimens in the academy's collection and I have also examined Schweinitzian specimens in some other herbaria and have obtained information from others who have examined specimens which I have not seen. All the specimens I have seen agree in external appearance, the fungus looking to the naked eye like brownish-orange, pustulate cushions usually growing in cracks in the bark. Unfortunately, microscopic examination does not show ascospores, which are necessary to distinguish the species with accuracy. In American herbaria one sees many specimens marked *Endothia gyrosa* by different collectors, but almost always what was said of Schweinitzian specimens applies to these, viz., they show no ascospores. The same is true of the specimens distributed in European exsiccati with the exception of the No. 986 of the *Erbario Crittogamico*. The problem is to find undoubted Schweinitzian specimens with ascospores and here one must be careful to distinguish between what may be and what certainly are Schweinitzian specimens. I have not finished my search, but from my experience up to the present time it looks as if it were doubtful whether good Schweinitzian specimens with ascospores can be found. Others, however, may be more successful, but since Schweinitz himself did not make use of microscopic characters it is hardly worth while to spend much more time in discussing what he understood by *Sphæria gyrosa*, since it is now known that there are at least two species in this country which in gross appearance resemble *Sphæria gyrosa*, but which differ in the size and shape of the ascospores.

Unless we can obtain more information than has yet been possible, it will be better to consider that the authority for the genus *Endothia* should be Fries, emended by

Cesati and De Notaris, who in their "Sferiacei Italici," 1863, gave a sufficiently detailed and accurate description of *Endothia radicalis* with a recognizable figure, so that, taken in connection with the specimen in the *Erbario Crittogamico*, there can be no doubt as to what they understood by the species. This may or may not be the same as the *Sphaeria radicalis* of Schweinitz, but certainly no genuine Schweinitzian specimens which I have ever seen would warrant any one in expressing a definite opinion. As far as one can distinguish species by their morphological, apart from their pathogenic, characters, *Diaporthe parasitica* seems to me to resemble the Italian *Endothia radicalis* so closely that they can not be separated specifically unless it be by some peculiarity not hitherto recorded.

There is still another point which should be considered. Is the fungus of our chestnut blight ever found on other trees? I have received a series of interesting specimens collected by Professor G. P. Clinton, which will illustrate this point. In some the bark of chestnuts and in others the bark of oaks is infested with an *Endothia* which in general appearance and in microscopic structure seem to me to be the same species. It is not, however, true that all the *Endothia* which occur on oaks belong to this species. There is an *Endothia* which appears to be common on oaks in the south, especially Florida and Louisiana, of which I collected material myself in New Orleans, which is clearly distinct from the *Endothia* of chestnuts, having ascospores much narrower and of a shape more nearly linear or bacilloid. Schweinitz gave as hosts of his *Sphaeria gyrosa* *Fagus* and *Juglans*, and of *Sphaeria radicalis* the exposed roots of *Fagus*. Too much weight, however, should not be placed on the hosts given by Schweinitz, for an examination of fungi of

different kinds collected by him shows that in his statements as to the hosts he was not always to be trusted.

The generic position of the chestnut fungus is of interest only to mycologists. It has been placed by Rehm in the genus *Valsonectria* and by Von Hoehnel in *Endothia*. If we accept the distinction between the Hypocreales and the Sphaeriales as generally understood, then *Diaporthe parasitica* should be placed in the former and removed from *Diaporthe* proper, which belongs to the Sphaeriales. The distinctions between the two groups, it must be confessed, are rather arbitrary in a more natural system, and the valloid genera of both groups might be put together. But the present condition of mycology does not admit the formulation of a truly natural grouping of genera. If, as I think, *Endothia* should be kept as a genus, then *Diaporthe* should be placed in that genus rather than in *Valsonectria*, which was not created until years later. Furthermore, even if *Diaporthe parasitica* be considered a true *Diaporthe*, the name *Endothia*, it should be remembered, antedates *Diaporthe* of Nitzschke.

In conclusion it may be said that the chestnut-blight fungus suggests a number of important and difficult questions to mycologists. A definite answer to some of them might throw some light on the possibilities of checking the disease, but wherever it may have come from, whether native or exotic, what we now know of its life history unfortunately gives us no reason to suppose that it could be seriously checked, much less extirpated, by any means which could be generally adopted, although something might be attempted where it is desired to protect special limited areas. At present it is the mycologist rather than the forester who is called on to investigate. From what has been said the

following problems remain to be solved. What is the relation of our chestnut-blight fungus to the *Endothia* on chestnuts in Italy? What species related to or identical with the chestnut fungus grow on other trees in this country, and how do they affect such trees? Is it possible to determine authoritatively whether *Sphaeria gyrosa* and *Sphaeria radicalis* Schweinitz are identical or distinct species, and are European botanists justified in believing that the *Endothia* of Europe is identical with either of the species of Schweinitz? Some of these questions mycologists may be expected to answer hereafter. Others may never be answered except by those in whom the power of observation does not exclude the exercise of a vivid imagination.

W. G. FARLOW

MORE TROUBLE FOR THE SYSTEMATIST¹

ON a former occasion, in an address as retiring chairman of Section F of the American Association for the Advancement of Science, your speaker had occasion to bid for the sympathy of his zoological colleagues, the immediate cause of distress being a prediction on the part of Dr. C. B. Davenport that "the future systematic work will look less like a dictionary and more like a table of logarithms."

In the ten years that have passed since that time, this particular specter has not reappeared, and the systematists have placidly gone on their way, apparently oblivious to the existence of logarithmic functions. This, however, may be due to their general belatedness and ultra conservatism; and it is not impossible that the threat of Dr. Davenport may still disturb the placidity of their dreams.

There are other troubles, however, that have arisen in the meanwhile, that are not a whit less disturbing than the one just mentioned.

A serious and most important effort to meet

¹ Read before the Central Section of the American Society of Zoologists, at Urbana, Ill., on April 5, 1912.

some of the difficulties of nomenclature has been made in the formation of the International Commission on Zoological Nomenclature, a thoroughly dignified and able body of zoologists, of which Dr. C. W. Stiles is the accomplished secretary and most influential American member. In the formation of this commission great pains were taken to make it truly international and representative. It was formally appointed by the most dignified body of zoologists in the world, the International Zoological Congress, and has striven earnestly and faithfully to perform its herculean task. It has been confronted with almost unsurmountable obstacles, and is certainly deserving of praise for its efficiency and courage.

That this commission would meet with serious difficulties was to have been predicted. In the attempt to formulate general laws it is inevitable that there should result individual cases of hardship and injustice, particularly when the law is inflexibly administered. Zoologists, like other men, are apt to be more or less restive under restraint, and consistency in applying the law of priority enacted by the International Commission was bound to involve irritating consequences.

These consequences are felt not only by the relatively small number of systematists, but even more keenly by the morphologists, embryologists and others who have to use zoological names, although they are spared the pains of making them, and are much inclined to cling fondly to those which have been rendered familiar by usage.

These men are naturally exasperated when they are required to call a holothurian a "bohadschioidean," and find it hard to recognize an actinian under the guise of "Dagysidæ."

Systematists have always, however, been subject to the execrations of their fellow zoologists along these lines, and at times deservedly so. It is inevitable, on the one hand, that classifications and hence names must change with the increase of knowledge and, on the other hand, it is equally certain that pedantic systematists and hair-splitting pur-

ists will arise and, with more zeal than judgment, create havoc with existing and revered classification. These men have no exemption from the common quota of error which afflicts mankind in general, but their mistakes are apt to be more than ordinarily disturbing. There is such a thing as excessive pedantry in every class of students, as there are men who crucify the spirit of the law in order to maintain the letter.

But, to return to the International Committee on Zoological Nomenclature, it must be conceded that it has unraveled skillfully and patiently many knotty problems in nomenclature, and has performed a function which is surely an important one.

But it has aroused a more or less active spirit of opposition by its strict application of the priority law, a rule that is at the very foundation of many of its decisions. This law reads as follows:

Art. 25. The valid name of a genus or species can be only that name under which it was first designated on the condition (a) that this name was published and accompanied by an indication, or a definition, or a description; and (b) that the author has applied the principles of binary nomenclature.

While there have been individual zoologists who have vigorously objected to the rigid enforcement of the priority rule, it remained for the Scandinavian and Finnish zoologists to make the first formal and organized protest. There was published in the *Annals and Magazine of Natural History* for December, 1911, an article entitled "A Vote against the Strict Application of the Priority Rule in Zoological Nomenclature, with an Introduction by Dr. Th. Mortensen."

This introduction is interesting reading for the insurgents. It reviews the efforts that have been made to induce the International Commission to agree to the recommendation that "certain very commonly used zoological names should be excepted from the law of priority," and states that the Commission on Zoological Nomenclature has shown no inclination to accept the recommendation, claiming that such a desire for exceptions to the

rule is not indicated by any great number of zoologists.

It seems that there was published in the number of the *Annals and Magazine of Natural History* for December, 1910, a portion of an advanced copy of the Report of the International Commission in which the commission invites all zoologists to send in, prior to November 1, 1910, a list of 100 zoological names. All systematists are invited, moreover, to send a separate list of 50 or 100 generic names in their specialty which they look upon as most important and most generally used, each name to be accompanied by the full and complete bibliographic reference, by the name of the type species and the name of the order and family to which the genus belongs.

This proposition Dr. Mortensen regards as "not very far from an absurdity." Perhaps this language is too strong to apply to a request from the International Commission on Zoological Names; but it is nevertheless exceedingly frank. It would be interesting, moreover, to know how many systematists there are in this body who are so situated that they could drop their ordinary work and supply, on short notice, such a list, with proper bibliographic references.

Dr. Mortensen, with the help of some of his colleagues, secured a vote from 122 professional zoologists in Scandinavia and Finland, and found that all but two of them were ready to sign the following statement:

The undersigned Scandinavian and Finnish zoologists protest against the strict application of the law of priority in all cases, and express the desire that the most important and generally used names should be protected against any change on nomenclatorial grounds.

The names and official positions of the signers are appended. Dr. Mortensen concludes as follows:

It is to be hoped that the zoologists of other countries will follow the example given here. When this has been done, and it has been definitely proved that the great majority object to the strict application of the priority rule, it may perhaps be expected that the tyranny of that notorious law, which has already done so much harm to

science, will be thrown off; and then, perhaps, the International Commission will see that it is rather its duty to arrange for the codification of the desired names in accordance with the wishes of the zoologists.

Upon looking up all of the evidence at hand, and also communicating directly with the secretary of the International Commission, I am forced to the conclusion that there is no disposition on the part of that commission to except any names whatever from the mandate of the priority rule.

It should be said here that prior to the protest from the Scandinavian and Finnish zoologists, the British Association and the American Society of Zoologists had recommended "that certain very commonly used zoological names should be excepted from the law of priority," and, aside from these formal actions there has been developed a considerable amount of individual hostility to the strict application of the law; and in some cases there is open revolt.

The practical working systematist is now confronted with a very serious and perplexing dilemma. He is forced to ask himself which of two courses he should pursue. Shall he adopt the ruling of the commission and adhere strictly to the law of priority, in which he will not be followed by a large and important class of his colleagues? Or, shall he use his judgment in each particular case which comes up for decision, and thus bring down upon himself and his work the criticism of another important class and have both condemned by the International Commission on Zoological Nomenclature, a body created by the International Congress, and having plenary powers to enforce this rule? And it must be remembered that a large number of active systematists are thoroughly in accord with the commission.

It surely seems as if the systematist here finds himself placed squarely between the Devil and the deep sea. It is, of course, not within the province of this paper to designate which is which.

Now it must be confessed that there is much to be said in favor of the attitude taken by

the commission in this matter. In the first place, there is great virtue in a clear-cut and definite law, one without any "ifs" nor "ands" about it; and this advantage is undoubtedly possessed by the law in question. And it is clearly to the advantage of the commission, as court of last resort, to have such a rule at its back. A law of this kind is administered with much more facility than a looser one, and the consistent administration of such a rule can bring no efficient criticism upon the commission, *provided* that the priority rule has been legally enacted!

As a matter of fact, the International Congress of Zoologists, although perhaps not a strictly legal body, is presumably the most thoroughly representative, indeed the only international body of zoologists in a broad sense, that exists, or has existed.

This body formally adopted the code, as formulated by the duly authorized International Commission on Zoological Nomenclature, at the Berlin meeting, in 1901. The commission itself was formally appointed in 1895 at the Leyden meeting.

Further amendments were submitted by the commission, and adopted by the International Congress at the Boston meeting in 1907. Meanwhile a number of zoologists expressed the wish that the commission serve as a court for the interpretation of the code, and it has consented to act in that capacity.

A careful review of the records and history of the commission has forced upon the writer the conviction that the priority rule has as thorough a sanction in law as can be given by the International Congress of Zoologists, and that there is nothing in the records which authorizes the commission to deviate from that law. Moreover, it appears that the commission is correct in declaring that it "has no legislative power," and it is difficult to see how it could assume the right to practically amend the priority rule.

If ordinary parliamentary usages are to be followed, it seems to be plainly indicated that the only power that can amend or abolish this rule is the International Congress itself, either on its own motion, or in response to a recom-

mendation of the International Commission. But the congress itself has decreed that "no proposition for change in the code is permitted to come before the congress unless it is presented to the Permanent Commission at least one year before the meeting of the congress."

A letter from Dr. Stiles, the secretary of the commission, informs me that the congress has gone on record to the effect that it demands "a unanimous vote of the commission before any matter will be considered by the congress."

It is interesting to speculate at this point whether there is any conceivable method by which a dignified body of scientists could more completely and finally tie its own hands than the one here solemnly consummated by the International Congress of Zoologists. The method, in brief, is as follows:

1. Appoint a commission with power to formulate a code.
2. Formally adopt that code.
3. Forbid any amendment to be introduced except through the commission.
4. Declare that nothing will be considered unless brought before the congress with the unanimous vote of the commission.

I submit, most respectfully, that nothing more perfect of its kind has every been perpetrated by any political machine or autocrat.

All that the commission has to do is to "stand pat." The congress has done the rest.

C. C. NUTTING

HENRY JAMES CLARK: TEACHER AND INVESTIGATOR¹

HENRY JAMES CLARK, or H. James-Clark as he often wrote his name, sometimes called, not inaptly, the first professor of natural history at this college, was the first trained zoologist to occupy a chair here. But hardly had he

¹An address delivered at the dedication of the building for entomology and zoology at the Massachusetts Agricultural College, November 11, 1910. In the preparation of this sketch I am indebted to Dr. Edward S. Morse and Professor A. E. Verrill for much valuable information.

entered upon its duties when he was called from this life in the flower of his age.

Born at Easton, Massachusetts, on the twenty-second of June, 1826, the son of a clergyman, his father moved to Brooklyn, N. Y., where he lived many years and where the son received much of his early training and was fitted for college. After completing his preparatory studies, he entered the University of the City of New York, and was graduated thence in 1848. From college he went as a teacher to White Plains, and while engaged in the study of botany, made observations upon the structure of *Chimaphila* and *Mimulus*, which he communicated to Dr. Gray. These and subsequent observations upon the flora of the neighborhood attracted to him the favorable notice of the latter, who invited him to Cambridge. Thither he went in 1850, and enjoyed for a time the advantages of a pupil and private assistant at the botanic garden. While a student there he taught, for a single term, the academy at Westfield, achieving much success as a teacher. Soon after this a taste for zoological studies, developed by the lectures of Professor Agassiz and frequent visits to the zoological laboratory, led him to abandon botany for what appeared the more fascinating study of animal life. Graduating from the Lawrence Scientific School in 1854, he became immediately after the private assistant of Professor Agassiz. Three years later Agassiz spoke of him enthusiastically, remarking to a friend, "Clark has become the most accurate observer in the country." In June, 1860, he was appointed assistant professor of zoology in the Scientific School at Harvard University, a position he held until the expiration of his term of office.

A few weeks following his appointment he went abroad, mainly for his health, traveling in England, France, Germany and Switzerland, often on foot, and visiting the leading universities and museums. He met many scientific workers, including Allman, Alexander Braun, Gegenbaur, Haeckel, Huxley, Leuckart, von Martius, Milne-Edwards, Schleiden, but especially Owen, whose guest

he was at Sheen Lodge, Richmond Park. While in Germany he attended the meeting of German Naturalists and Physicians at Königsberg, of which he has left an interesting account in his notes of European travel.

In the spring and summer of 1861 he gave a course of lectures on histology at the Museum of Comparative Zoology. One of his friends writes:

I remember his interesting lectures before our small class on cellular structure in plants and animals. His skill with the microscope and his rare ability to draw aided him greatly in making out the minutest details of cell structure. His personal qualities were of a kind to endear him to many friends, especially to those students who sought and obtained from him counsel and advice in their studies, as I did on many occasions.

The small class included Hyatt, Morse, Packard, Putnam, Scudder, Shaler and Verill.

Notwithstanding his constant investigations, Professor Clark found time to prepare a course of twelve lectures—the result of his microphysiological studies—which he delivered at the Lowell Institute in the winter of 1864. These were subsequently rewritten and published in 1865, under the title of "Mind in Nature; or the Origin of Life, and the Mode of Development of Animals." This work, based on structure and development in the animal kingdom, is crowded with original observations and testifies to years of the severest labor and independent thought. "It is in all respects," says Packard in 1873, "for its usually sound and clear thinking, its breadth of view and the amount of original work it contains, perhaps the most remarkable general zoological work as yet produced in this country."

Clark adopted and strongly urged the doctrine of spontaneous generation, from the facts afforded by the experiments of Jeffries Wyman, and on the question of evolution adopted views resembling those of Richard Owen. The original matter in the book is that relating to the structure of *Bacterium termo* and *Vibrio bacillus*, the theory of the egg and its polarity and bilaterality, and the

cellular structure of *Actinophrys*, with many other new points relating to the anatomy and physiology of the Protozoa and Radiates. It anticipated also certain points in histology, and the structure of the Protozoa and Sponges especially, which have made the succeeding labors of some European observers notable.

In 1866 Professor Clark accepted the chair of botany, zoology and geology at the Agricultural College of Pennsylvania, where he remained three years, exchanging it in 1869 for similar duties at the University of Kentucky. Neither of these posts was agreeable to his taste, chiefly on account of the pressure of college duties, which left him but little time for abstract investigations. It was, therefore, with great readiness he accepted the call to this college in 1872.

Here his duties were of a more congenial nature, and he applied himself with renewed energy to teaching and soon began the formation of a museum—a working collection of comparative and pathological anatomy. Turning to his first and only report—remarkable for its clearness, particularity and insight—we find that he taught human anatomy and physiology, comparative anatomy and zoology, and comparative physiology. These studies were to form the groundwork for a course in general and veterinary pathology. He lays stress on the importance of the objective method of teaching in the class-room and of laboratory instruction. "Having mastered," he says, "the general principles of structure and relation throughout the length and breadth of the animal kingdom, the rawness of total ignorance is supplanted by a new habit of thought, and a proneness to make further inquiry upon meeting with any object in nature. Here, then, comes the time for laboratory practise. Supplied with scalpel and magnifier, the student should be required to work out topics upon unprepared specimens. If he has acquired the smallest grain of interest in the matter previously, patience will enter where it could not possibly have existed before. He learns the art of seeing and knowing what he looks at; he becomes by degrees an observer; and in doing that, he is

also becoming unconsciously a draughtsman, and when required, as he should be, to produce with pencil what he sees, if he wants to do it, he will do it instinctively." Lastly, Clark had in view graduate courses for advanced work and for special training.

His work was now interrupted by a severe illness. Never robust, his assiduous and confining labors had seriously impaired his health. As early as 1857 are entries in his diary of symptoms indicating that the seeds of the disease that was to cut him off in his prime were then sown. After much suffering, on the first of July, 1873, at the age of forty-seven, his useful life came to an end. He was a member of the leading scientific societies in this country, including the National Academy of Sciences, which up to that time was limited in membership to fifty of the foremost scientists of the country.

His first love for science, writes one who knew him well, seems to have grown from his fondness for flowers. After he became a student of Professor Agassiz his love for botany remained undiminished. He studied it in after years from the side of vegetable histology and morphology in connection with and as illustrating the histology and morphology of animals. The influence of his knowledge of botany on his zoological studies was marked. It prepared him for his studies on spontaneous generation, on the theory of the cell, on the structure of the Protozoa and the nature of protoplasm. In studying the lasso-cells of the acalephs, he traced their analogical resemblance to the stinging hairs of the nettle. By his intimate knowledge of the spores of the smaller algæ he was able to point out some of the characters separating the lowest Protozoa from the spores of plants, and aid in the work of Thuret and others in eliminating from the animal kingdom certain vegetable spores which had been originally described as Infusoria.

In his first scientific paper, communicated by Dr. Gray in 1856, he showed that in most of our North American gentians the ovules are spread over the whole parietes of the ovary, either irregularly or in vertical lines on the

veins. His next paper was on the peculiar growth of rings in the trunk of *Rhus toxicodendron*, and this was supplemented by further studies on the eccentricity of the pith of *Ampelopsis quinquefolia* and *Celastrus scandens*. He made experiments for a series of years on the value of the bark to the life of the tree. He observed the relation and development of the filaments which connect the anthers to the sepals of *Comandra umbellata*. In his paper on the identity of the vibrios and the muscular fibrillæ, he showed how the latter during decomposition break up transversely, the fragments assuming the form and movements of the former. He also made observations on the absorption of albumen in the cells of plants. His last purely botanical paper (1859) was on the nature of the glandular dots of the pine. His skill in the use of the fine lenses made by Spencer (under his direction) enabled him to see more than his predecessors of the true relations of these dots. But his botanical studies did not end here, as may be seen by reference to his diaries and his frequent allusions to the lower algæ and to vegetable histology in "Mind in Nature." In his walks he often botanized, and contributed in this way to Gray's botanical textbooks. Thus with the training he received from Gray and Agassiz, he looked upon the world of organized beings from both the botanical and zoological side. He well deserves the name, *biologist*.

Between 1856 and 1863 he was associated with Agassiz in the preparation of the anatomical and embryological portions of the great work entitled "Contributions to the Natural History of the United States." To these volumes he was a large contributor, most of the histological and embryological portions of the work being his, and more than half the plates illustrating the embryology and histology of the turtles and acalephs bear his name. "In the preparation of this part of my work," says Professor Agassiz, "I have received much valuable assistance from my friend and colleague Professor H. J. Clark, who has traced with me, for more than nine years, the metamorphoses of our Acalephs,

and especially those of the Hydroids. He discovered the peculiar structure of the lasso-cells of the Ctenophora."

During this time Clark began the serious study of the Protozoa, undoubtedly compelled to do so in order to properly interpret the histological facts then accumulating in the study of the Radiates. After leaving Cambridge he studied the Infusoria and lower plants, and made drawings and notes comprising descriptions of many new forms of Infusoria. He planned an extensive work upon this subject, which, had he lived to complete it, might have equalled if not surpassed Claparède and Lachmann's famous work on the Infusoria. He did not dissociate the Protophyta from the Protozoa, regarding them as almost inseparable in nature; thus, in his lectures to his classes, well nigh anticipating Haeckel's classification of the lowest forms of the animal and vegetable kingdom into the Protista and Protozoa.

In his first paper on *Actinophrys* (1863) he announced the discovery that "all vibratile cilia originate in the amorphous intercellular substance," and do not form direct prolongations of cells, *i. e.*, that cilia are prolongations or extensions of the protoplasmic substance of the cells from which they arise. The same year he discovered the eggs of *Tubularia*, and showed that there was but one type of development in the Hydromedusæ (excepting the Narcomedusæ and Trachymedusæ), and that the differences observed in the developmental process were merely modifications of degree and not of kind, an exceedingly valuable addition to our knowledge of the affinities of the various groups of Hydromedusæ.

Foremost, perhaps, among his several discoveries with the microscope was that of the true nature of the cilio-flagellate infusorians and the sponges. In 1866 appeared a brief paper, entitled "Conclusive Proofs of the Animality of the Ciliate Sponges, and of their Affinities with the Infusoria Flagellata." While Clark had endeavored to show in his Lowell Lectures that there was a unity of plan in the organization of the Protozoa, their

bodies being arranged in the form of a helix, he now endeavored to prove that the sponge did not depart from the protozoan type. In the full memoir, published about a year later, under the title "*Spongiæ Ciliatæ as Infusoria Flagellata*," he attempted to establish the homology of the flagellate cells of the sponge with the flagellate Infusoria. His discovery of the flagellated cells of living sponges and demonstration of their animal nature was a great step in advance of previous observers. While, as Clark observes, Carter had first detected the true criterion of their animality, this was confirmed and demonstrated still more completely by Clark himself, as acknowledged by Carter in his "Confirmation of Professor James-Clark's Discovery of the True Form of the Sponge-cell (Animal)."

The Choanoflagellata, or collar-bearing flagellate animalcules, were discovered by Clark, and his further discovery that the flagellated (ciliated) chambers of sponges are lined by collared cells of the same peculiar structure as the individual Choanoflagellata, led him to regard the sponges as colonies of Choanoflagellata. The views maintained by Clark with reference to the position and affinities of the sponges were, that these organisms must be regarded as compound colonial forms of Flagellata, whose units, in the case of *Leucosolenia*, exhibited a type of structure essentially similar to that of *Codosiga* and *Salpingoeca*—genera established by him to receive his collared cell forms—but might possibly in other instances more closely approximate to that of *Monas* (*Spumella*) *Bicosoeca* or *Anthophysa*. In these views he was supported by the observations of Saville Kent and Stein, and in the main by those of Carter and to a less extent by Balfour, but opposed by Haeckel and F. E. Schulze. The subsequent discovery by Saville Kent of *Proterospongia* (*Savillia*) at that time rendered the derivation of the sponges from the Flagellata at least a tenable hypothesis, while Balfour considered them as an intermediate group between the Protozoa and Metazoa.

In the last paper he published Clark compared the arguments adduced by Haeckel in

favor of the coelenterate affinities of the sponges with the actual structural composition of *Spongilla* and *Leucosolenia*, and reached the conclusion that the relationship of the sponges to certain flagellate Protozoa was so distinct and decisive as to forbid their logical inclusion among the representatives of any other class. The universal and characteristic collared cells of sponges point emphatically to a choanoflagellate ancestry and, as a recent authority has observed, in the present state of our knowledge it would be difficult to frame a definition of the Protozoa which should absolutely exclude the sponges. His work on flagellate Protozoa and sponges was a valuable contribution to science. Since his time great advance has been made in our knowledge of the histological structure, mode of reproduction and embryological development of these organisms, due mainly to the opportunities offered by novel and refined methods of technique. Had the art of making thin sections and the staining of tissues been known in his day, he would certainly have anticipated much of the later work of cytologists and embryologists.

In the use of the microscope, Clark showed not only mechanical skill and ingenuity, but a patience, caution, and experience in difficult points in histology, which undoubtedly placed him at the head of observers in this country and rendered him perhaps inferior to few in Europe. He used the highest powers with a skill that few if any living observers have surpassed. He suggested improvements carried out by Spencer and Tolles in this instrument. In 1857 Professor Agassiz sent him to Canastota to confer with Spencer, and as a result a microscope was made by him which was fully equal to any made at that time in Europe. Clark suggested that we must have three kinds of objectives: one with the field extremely flat; another, an immersion lens—the first made, so far as we are aware, and now so universally used; and a “third with a deepening focus extending as far as possible beyond that of the ordinary kind, for the purpose of viewing objects as a whole, in order to

ascertain the relations of their different parts.” This microscope was in use in 1859.

In 1878, five years after the death of Professor Clark, the Smithsonian Institution published, as one of its Contributions to Knowledge, his monograph of the “Lucernariae and their Allies.” This group was the subject of his last studies, though one which had early engaged his attention. Complete and elaborate as it is so far as it extends, this beautiful memoir is only a fragment of what was evidently designed to cover at least fifteen parts, two parts only having an actual existence. It has been well said that a broken shaft would represent both the author's life and this posthumous work, each symmetrical and thoroughly finished to the point where they suddenly broke off.

The Lucernarians were not regarded by Clark as truly radiate animals, but in a degree bilateral, with a fore and hinder end. The commonly received theory at that time that the so-called Radiata are founded upon the idea of radiation, was combated by him in 1865. The views of the present day coincide in the main with his—that radiation is, on the whole, a superficial feature, not always constant in Cuvier's Radiata, though often well marked. He regarded the so-called polymorphic individuals as “organs under various disguises,” and he ascribed a high degree of individuality to the jelly-fish, *Pelagia*, and only a less amount to *Lucernaria*. He believed with the advanced histologists of his day that “cells so-called (no matter whether constituted according to the older histologists or according to the most recent theory) are, after all, of secondary importance, and that the *cytoblastema* or protoplasm (which we do not distinguish from inter-cellular substance) is in the main an *essential element*, the potential progenitor of all tissues, and that it projects itself into the utmost feature of the living body by a process of self-proliferation. Through this, and this only, can a true law of continuous development be illustrated; while the various forms of cell-tissue, and fiber-tissue, and bone-tissue, etc., are but the disjointed collateral developments,

each one irrespective of the other, from the continuous, onward stream of cytoblastema." He says, further, that "all Rhizopods are moving, sentient masses of *Cytoblastema*, and that alone."

Clark was admirably adapted by nature for doing histological work of the highest order. He possessed that philosophic insight of the true naturalist which often enables him to *divine* much further than he can perceive in the tracing of relationships and to anticipate what the microscope is to reveal. At the time he began his work as an observer, zoological science in America was especially deficient in histological investigations, and he did more than any one else to remove this reproach upon American biology.

"Henry James Clark," said Asa Gray at the time of his death, "deserves to be enrolled in the list of botanists. Although his high reputation was won in another department, he was an excellent botanist before he became Mr. Agassiz's assistant and gave himself to zoological investigation: the present writer was indebted to him for more than one interesting discovery of points of structure. He is thought to have been the ablest microscopic investigator which this country has produced." "His labors as a zoologist," said James D. Dana, "especially in those departments requiring difficult microscopic research, had placed him among the two or three first in the country, and given him a world-wide reputation. He was always working, and full of enthusiasm in science, and also a most genial and excellent man."

In the preface to volume one of the "Contributions to the Natural History of the United States," dated October 3, 1857, Professor Agassiz says:

Mr. H. James Clark has assisted me from the beginning of my investigation of the embryology of these animals, and drawn, with untiring patience and unsurpassed accuracy, most of the microscopic illustrations which adorn my work. I owe it to Mr. Clark to say, that he has identified himself so thoroughly with my studies since he took his degree in the Lawrence Scientific School, that it would be difficult for me to say when I

ceased to guide him in his work. But this I know very well, that he is now a most trustworthy observer, fully capable of tracing for himself the minutest microscopic investigation, and the accuracy of his illustrations challenges comparison.

In a lecture given at the summer school of Natural History at the Island of Penikese, early in July, 1873, Professor Agassiz announced the death of Professor Clark and spoke in the highest terms of his work and of him as a man. He said that as a microscopist and histologist he regarded him as fully equal if not superior to Ehrenberg, who was at that time considered the best in the world.

Professor Fernald, to whom we owe the department of entomology in this college and in whose honor we are gathered to-day, has expressed the opinion that he was the most brilliant of all the young men that Agassiz drew round him when he first came to this country; that as an artist in illustrating his work he probably had few if any equals, and as an observer and investigator he must be placed in the front rank of the naturalists of his time. In marine zoology he probably had no superior, and if his life had been spared he would undoubtedly have left a marked impress on the college.

Three things can be said of Clark. He was a genius, he had the best of teachers, and he made the most of his opportunities. The secret of his success as an investigator may be stated in his own words taken from his diary, where he says, "I made it a rule to practise the utmost rigidity and thoroughness in my researches, without regard to time consumed or the value of the results." Such was the life of Henry James Clark, full of supreme devotion to science and showing an indomitable energy in the search for truth.²

FREDERICK TUCKERMAN

² Several species bear his name. Agassiz dedicated to him the aculeph, *Idyiopsis clarkii*; Bütschli the animalcule, *Salpingæa clarkii*—a name later bestowed by Stein upon another form of the same genus. His services are also commemorated in *Ascoris clarkii* of Verrill, the most delicate species of calcareous sponge found on our coast.

SCIENTIFIC NOTES AND NEWS

COMMEMORATION day will be observed by the University of Glasgow on June 25, when Professor F. O. Bower, F.R.S., will deliver an oration on "Sir Joseph Hooker."

THE Aero Club of Washington held a field day last Monday in commemoration of the anniversary of Secretary Langley's first aerodrome flight on May 6, 1896. Professor Willis L. Moore, president of the club, gave an address on Langley's work and influence on aviation. General Robert Shaw Oliver spoke on the work of the army in aviation, and Captain W. I. Chambers, on the work of the navy.

A PORTRAIT of Dr. Edgar F. Smith, provost of the University of Pennsylvania, painted by Mr. Hugh H. Breckenridge, will be presented to the university by the members of the class of 1902 College on the occasion of their tenth anniversary this June.

THE speaker at the annual commencement exercises of the Johns Hopkins University on June 11 will be Dr. William C. Gorgas, chief sanitary officer of the Panama Canal Zone and member of the Isthmian Canal Commission.

DR. WILHELM FIEDLER, professor of mathematics at Zurich, has celebrated his eightieth birthday.

MAJOR VON ABERCRON, known for his work in aeronautics, has been made an honorary doctor by the University of Marburg.

DR. ADOLF VON KOENEN, professor of geology at Göttingen, has received the honorary doctorate of engineering from the Technological Institute of Hanover.

AT the celebration of the seventy-fifth anniversary of the foundation of the University of Athens, on April 10, honorary degrees in medicine were conferred, as reported in *Nature*, on Professors von Behring (Marburg), Celli (Rome), Ehrlich (Frankfort), Exner (Vienna), Golgi (Pavia), Kronecker (Berne), Laudouzy (Paris), Richet (Paris), Sir Ronald Ross (Liverpool), Roux (Paris), Schulze (Würzburg), Weichselbaum (Vienna) and others. The degree of doctor of philosophy was conferred on Sir Donald MacAlister

(Glasgow), Delbrück (Jena), Dörpfeld (Athens), Gubernatis (Rome), Harnack (Berlin), Kenyon (London), Mahaffy (Dublin), Wheeler (Berkeley) and others; and the degree of doctor of science on Professor Depéret (Lyons), Halácsy (Vienna), Lacroix (Paris), Lepsius (Darmstadt), Partsch (Leipzig) and Philippon (Bonn).

THE third annual award of the Hunterian Society's medal has been made to Dr. A. Goulston, of Heavitree, Exeter, for his essay on "The Use of Sugar in Heart Disorders."

GRANTS have been made from the C. M. Warren Fund of the American Academy of Arts and Sciences as follows: To Professor H. G. Byers, University of Washington, \$250, for work upon the passivity of metals. To Professor W. D. Harkins, University of Montana (to be at Chicago University), \$300, for work upon the energy relations in a surface between two liquid phases. To Dr. Latham Clark, Harvard University, \$150, for work on the paraffin hydrocarbons.

MR. R. N. LYNE, director of agriculture in Portuguese East Africa, has been appointed the director of the new agricultural department of Ceylon.

DELEGATES have been appointed by the Academy of Natural Sciences of Philadelphia as follows: To the Second International Congress of Entomology, Dr. Henry Skinner, Professor Philip P. Calvert and Dr. W. J. Holland; to the Eighteenth International Congress of Americanists, Sir Thomas Lauder Brunton.

DR. EDWARD BARTOW, director of the State Water Survey and professor of chemistry at the University of Illinois, has been appointed a delegate to the fifteenth International Congress of Hygiene and Demography, to be held in Washington, September 23 to 28.

DR. H. B. WARD, head of the zoological department of the University of Illinois, has been appointed delegate of the Illinois Academy of Science to the meetings of the Iowa Academy of Science at Des Moines. He will deliver two addresses.

THE New York Section of the American Chemical Society has appointed a committee on occupational diseases in chemical trades as follows: Charles Baskerville, professor of chemistry, College City New York, *Chairman*; E. C. Uhlig, chief chemist, Brooklyn Union Gas Co., Brooklyn, *Secretary*; George P. Adamson, Baker and Adamson Chemical Co., Easton, Pa.; W. H. Bassett, American Brass Co., Waterbury, Conn.; Wm. F. Doerflinger, consulting chemist, 52 Beaver St., New York City; H. M. Kaufman, Mutual Chemical Company of America, 55 John St., N. Y.; A. C. Langmuir, chairman of the New York Section, American Chemical Society, 9 Van Brunt St., Brooklyn, N. Y.; Geo. A. Prochazka, general manager Central Dye Stuff and Chemical Company; Geo. D. Rosengarten, Powers, Weightman and Rosengarten, Philadelphia, Pa.; A. H. Sabin, consulting chemist for the National Lead Company, 129 York St., Brooklyn, N. Y.; Charles L. Parsons, mineral chemist, Bureau of Mines, Washington, D. C. This committee will work in co-operation with the committee of the Association for Labor Legislation.

DEAN EUGENE DAVENPORT, of the College of Agriculture of the University of Illinois, was the speaker at the recent commencement exercises of the University of Nebraska College of Agriculture.

R. G. DUKES, professor of applied mechanics at Purdue University and second of the exchange lecturers with the University of Illinois, lectured April 26 on "The Recent Discoveries in Physical Science and their Bearing on the Progress of Engineering." Mr. O. P. Hood, who is mechanical expert for the United States Bureau of Mines at Pittsburgh, also addressed the meeting.

DEAN C. H. JOHNSTON, of the University of Kansas, gave three lectures before the School of Education of the University of Illinois on April 29 and 30 on present problems in high school organization.

THE annual commencement address of the Missouri School of Mines will be given by

Mr. James R. Finlay, of New York City. Exercises will be held on the morning of May 31. The graduating class numbers forty.

THE University of Pennsylvania Chapter of the Society of the Sigma Xi initiated twenty-nine new members on April 23. Among them were Professor Samuel Christian Schmucker, of the West Chester State Normal School, and Mr. Witmer Stone, a curator in the Academy of Natural Science in Philadelphia. Professor George Hervey Hallett, of the University of Pennsylvania, addressed the Chapter on the subject of "Hyperspace." Professor George F. Sever, president of Columbia chapter, was present as a delegate from that chapter.

THE Museum of the University of Pennsylvania has arranged to send an expedition to the Amazon under the direction of Mr. Algot Lange. The expedition will be furnished with a steamer which will be large and seaworthy enough to carry the party from New York to the mouth of the Amazon and up the Amazon for several thousand miles to the tributaries where the Indian tribes will be studied and collections made for the next three years.

MR. GEORGE BORUP, a graduate student in geology at Yale University, and Mr. S. W. Case, a graduate student in mining, were drowned in Long Island Sound on April 28, by the overturning of a power canoe. Mr. Borup accompanied Commander Peary in his Arctic expedition, and had planned to undertake this summer with Mr. D. B. McMillan, an expedition to Crocker Land, as described in a recent issue of SCIENCE.

THE heirs of the late Frau Adelheid Bleichröder have given the German Association of Physicians and Scientific Men \$25,000 for the support of research work in medicine and the sciences contributory to medicine.

THE provisional arrangements for the forthcoming celebration of the 250th anniversary of the Royal Society, as given in *Nature*, are as follows: Monday, July 15—An evening reception of delegates at the rooms of the Royal Society. Tuesday, July 16—In the

morning a commemorative service in Westminster Abbey; in the afternoon the official reception of delegates at the Royal Society and presentation of addresses; in the evening a commemorative dinner at the Guildhall. Wednesday, July 17—In the morning visits to places of interest in London; in the afternoon the Duke of Northumberland gives a garden-party at Sion House; in the evening a conversazione in the rooms of the Royal Society. Thursday, July 18—In the morning visits to places of interest in London; in the afternoon H.M. the King gives a garden-party at Windsor, to which the delegates and fellows of the society will be invited. Friday, July 19—The delegates will visit Oxford and Cambridge Universities.

THE coming of age of the Babcock butter-fat test, which was invented by Professor S. M. Babcock, of the University of Wisconsin, twenty-one years ago, has been recognized by the university in a new bulletin written by Dean H. L. Russell, of the College of Agriculture, in which he gives the history and growth of the use of the test throughout the world. Pictures of the original testing machine, now in the dairy school of the university, and of the latest improved forms of testers are shown in the bulletin.

THE prize of the foundation George Montefiore will be awarded 1914 for the scientific advancement or application of electricity. The works may be printed or in manuscript and must be in French or English. The value of the prize is \$4,000 and the works must be received not later than March 31, 1914.

THE Warren Triennial Prize, founded by the late Dr. J. Mason Warren, of Boston, in memory of his father, will be awarded in 1913 for the best dissertation on some subject in physiology, surgery or pathological anatomy, the arbitrators being the physicians and surgeons of the Massachusetts General Hospital. The amount of the prize is \$500.

THE surgeon general of the army announces that preliminary examination for the appointment of first lieutenants in the army medical corps will be held on July 15, 1912, and Sep-

tember 3, 1912, at points to be hereafter designated. Full information concerning these examinations can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to securing an invitation are that the applicant shall be a citizen of the United States, shall be between twenty-two and thirty years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training, after graduation. The examinations will be held concurrently throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. The examination in subjects of general education (mathematics, geography, history, general literature and Latin) may be omitted in the case of applicants holding diplomas from reputable literary or scientific colleges, normal schools or high schools, or graduates of medical schools which require an entrance examination satisfactory to the faculty of the Army Medical School. In order to perfect all necessary arrangements for the examination, applications must be complete and in possession of the adjutant general at least three weeks before the date of examination. Early attention is therefore enjoined upon all intending applicants. There are at present sixty-eight vacancies in the medical corps of the army.

THE trustees of Phillips Academy, Andover, Mass., have authorized the department of archeology to begin an archeological survey of Maine this year. Already the curator, Mr. W. K. Moorehead, has had an agent of the department in Maine for some weeks. A number of camp sites, cemeteries and other places have been entered on the standard government maps. It is proposed to map the entire state. The indications are that the ancient Indian population was most numerous along the coast, about Sebago Lake, on the lower Penobscot, Moosehead Lake and Cham-

berlain Lake. A number of students will accompany Mr. Moorehead and others to Maine in June. The excavation of one or two sites will be begun in May.

THE University of Michigan Museum of Natural History will send an expedition to Nevada in July and August to secure zoological material for research and illustrative purposes. The investigations will be carried on as the museum conducts all of its field work outside of the state, that is, only a few groups and a small area will be considered and these will receive detailed study. One half of the expense of the expedition will be provided by Mr. Bryant Walker and one half by the university. The museum will also this summer begin a biological survey in the northern part of Chippewa County, Michigan. Hon. George Shiras 3d has provided for the expenses that will be incurred in the preliminary work this summer, and the Michigan Geological and Biological Survey and the museum will complete the study.

THE program of business for the eighteenth annual meeting of the British Medical Association in Liverpool has been issued. The representative meeting will begin on July 19. The annual general meeting will take place on the afternoon of July 23, and the president, Sir James Barr, will deliver his address in the evening. The sectional meetings will be held on July 24, 25 and 26. The address in medicine will be delivered by Dr. G. A. Gibson, of Edinburgh, and the address in surgery by Mr. F. T. Paul, of Liverpool. The scientific program of the meeting will be conducted in 20 sections.

THE Anglo-American Medical Association, which was founded in Berlin some eight or nine years ago and reconstituted in 1910, has recently acquired, as we learn from the *British Medical Journal*, well-situated quarters of its own at the Hotel Atlas, 105, Friedrichstrasse. They are open daily from 12 to 2 for luncheon; the assistant secretary is in attendance from 1:30 to 4:30 to give information; and from 9 P.M. to 12 P.M. the rooms are open for social purposes, writing and perusal of the journals

with which the association keeps itself supplied. In addition, there is a formal meeting each Saturday at 8 P.M., when dinner is taken and a paper read and discussed. One of the special objects of the association is to make the visits of British and American medical men to Berlin pleasant and informing by putting them promptly in touch with what is going on in medical and surgical circles, and by enabling them to meet on a social footing their colleagues in Berlin. It publishes a year-book, the current issue of which contains, in addition to other notes, information as to courses on various subjects more or less constantly in progress, and also as to vacation and other special courses. The honorary secretary and treasurer of the association is Mr. H. R. Carstens.

THE Smithsonian Institution reports the completion of the fish collecting in the Panama Canal Zone, and the safe return of one of its representatives. Several of the specialists who have been making collections in this region have been back some time, but the members of the party who have been collecting fishes did not complete the work until early in April, remaining three months in the field. This branch of the work has been supported by the cooperation of the U. S. Bureau of Fisheries and the Field Museum of Natural History, Chicago, Mr. S. F. Hildebrand representing the former and Dr. S. E. Meek the latter. After the work was finished, and the collections shipped to Washington, Dr. Meek went on a visit to Costa Rica, while Mr. Hildebrand returned to Washington, where he arrived on April 13. Mr. Hildebrand reports a most successful trip, and feels confident that all the important fishes of the Canal Zone are represented in the collections which fill some 5 or 6 barrels. The weather was favorable and the work was greatly facilitated by the many privileges and courtesies extended by the Canal Commission. Quarters were furnished by the commission, and each member of the survey was supplied with the regular hotel and commissary books, according him the privileges of an employee.

Living under these arrangements, the party was enabled to secure excellent meals at a very low cost. Besides the work in the Canal Zone proper, the members of the survey made trips into the neighboring territory in search of specimens and data not available within the actual bounds of the zone, but obtainable in the same faunal area or an adjoining one. One of these expeditions carried the party into the Darien country and along the banks of the Rio Tuyra, which lies on the Pacific side of the isthmus about 150 miles distant from Panama. The fauna of this country was found to differ considerably from that of the Canal Zone. The fish collectors, unlike those concerned with some other classes of animals, find it impracticable to classify their specimens while in the field, and for this reason it is difficult to say just what has been obtained, other than that a good-sized collection was made, fully as large as that of last year. The fish were caught in nets and traps of several kinds; often in great numbers, the collectors selecting the best and most desired specimens which are at once prepared and packed in tanks for shipment to the National Museum. Among the different kinds of salt-water fishes secured were sharks, tarpon, jew-fish, snappers, groupers and croakers. There were also many of the cat-fishes which are so very abundant on the Pacific slope and along the coast of Panama. The collectors point out the special value of this survey in so far as concerns the fish fauna which will become completely changed and intermixed when the canal is finished, and the waters of the inland lakes and the two oceans become intermingled. As is well known, many salt-water fishes ascend fresh-water streams for long distances, and it is now seen that in this manner many will doubtless find their way to the great Gatun Lake. Some will probably remain here, while others will pass on into the ocean. At present the fish faunas of the Atlantic and Pacific slopes and the two coasts of the zone appear well defined, but it is believed that a subsequent survey, in from five to ten years time, will reveal great changes.

UNIVERSITY AND EDUCATIONAL NEWS

THE late Dr. Francis Bacon, a physician of New Haven and connected with the Yale Medical School, has bequeathed \$100,000 to the New Haven County Antituberculosis Society. He has made Yale University his residuary legatee, the bequest to be used as a scholarship fund in the college.

MR. A. W. OPPENHYM, of New York, by his will created a trust fund of \$275,000, which at his widow's death shall go in equal parts to the Mt. Sinai Hospital, the German Hospital and Columbia University. It is provided that the Columbia University fund is to be used for the research into the cause, prevention and cure of cancer.

MR. JOHN TATLOCK, of New York, has given to Columbia University a collection of astronomical works consisting of 261 volumes and about 1,200 pamphlets.

AGRICULTURAL HALL, just built by the University of California at a cost of \$200,000 to house some portion of its teaching and investigating in agriculture, will be completed by commencement, May 15, 1912. This new white granite building, roofed in red mission tile, and picturesquely set on an eminence looking south toward the Dana Street entrance to the campus, is one of the permanent buildings of the Phoebe A. Hearst plan. It is fireproof in construction, with steel frame and concrete floors and roof.

THE bill appropriating two hundred and fifty thousand dollars for the development of work in public health and medicine at the site of the University of Illinois in Urbana-Champaign, failed of passage in the special session of the legislature. Although only four votes were recorded against it; yet owing to the fact that at a special session a two-thirds majority is necessary to pass an appropriation bill, involving in this case thirty-four votes, and at no time were more than thirty-five members present, it made it possible for even two votes to defeat the bill. The trustees will renew their request for an adequate appropriation for scientific work in medicine at the next session of the legislature.

PROFESSOR GORDON H. TRUE has been appointed director of the Nevada Experiment Station, at Reno.

DR. ARTHUR B. LAMB, professor of chemistry and director of the Havemeyer Chemical Laboratory of New York University, has been appointed assistant professor of chemistry at Harvard University. Professor Solon I. Bailey has been promoted to the Philips chair of astronomy vacant by the retirement of Professor Arthur Searle, and Dr. Charles Palache has been promoted to a full professorship of mineralogy.

DR. IRA W. HOWERTH, of the University of Chicago, has been appointed professor of education and director of university extension in the University of California. Dr. J. C. Merriam has been promoted to a full professorship of paleontology.

DR. W. M. CONGER MORGAN, assistant professor of chemistry at the University of California, has been appointed professor of chemistry in Reed College.

DR. FRANZ DOFLEIN, associate professor of zoology at Munich, has been called to the chair of zoology at Freiburg.

DISCUSSION AND CORRESPONDENCE

NON-EUCLIDEAN GEOMETRY IN THE ENCYCLOPÆDIA BRITANNICA

THE sixth heading under the word *Geometry* is *Non-Euclidean Geometry*. The article is by Whitehead and Bertrand Russell, the best men in England to have written it, and is worthy this one of the three greatest works of reference in the English tongue, the others being Murray's dictionary and the *Century*.

It begins:

A short historical sketch will . . . describe the famous and interesting progress of thought on the subject.

But first it gives characteristic properties, beginning with Bolyai's space.

The sum of the three angles of a triangle is always less than two right angles. The area of the triangle ABC is $\lambda^2(\pi - A - B - C)$. If the base BC of a triangle is kept fixed and the vertex A

moves in the fixed plane ABC , so that the area ABC is constant, then the locus of A is a line of equal distance from BC . This locus is not a straight line.

I have called it an *equidistancial*.

The angle A [which a perpendicular to one of two parallels makes with the other] is called by N. I. Lobatchewsky the "angle of parallelism."

Here as everywhere else in the spelling of Lobachevski's name, the authors have made a very regrettable slip. Lobachevski transliterated his own name into French as *Lobatcheffsky*, and so it stands in the "édition de Kasan," 1886.

In 1869 Potocki transliterates the name into French as *Lobatchefsky*, and this spelling is used in the French prospectus issued at Kasan to found the great Lobachevski prize; and the volume "In Memoriam N. I. Lobatschewskii," bears as subtitle, *Collection des mémoires présentés à la Société Physico-mathématique de Kasan pour la fête de l'inauguration du monument de Lobatchefsky (1/13 Septembre, 1896) par Mm. Hermite, Halsted, Girardville, Laisant, Lemoine, Neuberg, Ocagne*.

My contribution I wrote while sojourning in Kasan, where I had abundant opportunities to learn the name. Gino Loria adopts in Italian the spelling *Lobatschewfsky*. Now Lobachevski himself also transliterated his name into German, and it stands on the title page of the original edition of his *Geometrische Untersuchungen* as *Lobatschewsky*. But Stäckel and Engel Germanize it as *Lobatschewskij*, the abomination *ij* being an attempt to represent the *i*, as in Italian, and the *j*, very short, with which the name ends in Russian. My friend Sommerville falls into this pit, and spells the name *Lobačevskij*. Had he dropped that *j* and replaced his fifth letter by its exact equivalent, our *ch* as in church, he would have had the proper English transliteration, *Lobachevski*.

If we be willing to permit in the *Encyclopædia* the final *y*, still as English its *t* is superfluous and its *w* is indefensible, so that, as the name occurs 25 times, there are 50 places where the quicker the stereotype plates

are corrected the better. Let not the name of a world hero be bungled in the world language, English.

The theory of parallels as it exists in hyperbolic space has no application in elliptic geometry. But another property of Euclidean parallel lines holds in elliptic geometry, and by the use of it parallel lines are defined. Thus throughout every point of space two lines can be drawn which are lines of equal distance from a given line l .

This property was discovered by W. K. Clifford. The two lines are called Clifford's right and left parallels to l through the point.

In both elliptic and hyperbolic geometry the spherical geometry is the same as the "spherical trigonometry" in Euclidean geometry.¹

The historical sketch is blemished by the unwarranted prominence it gives to Gauss. It says:

We find him in 1804 still hoping to prove the postulate of parallels. In 1830 he announces his conviction that geometry is not an a priori science; in the following year he explains that non-Euclidean geometry is free from contradictions, and that, in this system, the angles of a triangle diminish without limit when all the sides are increased. He also gives for the circumference of a circle of radius r the formula $\pi r k(e^{r/k} - e^{-r/k})$.

[In this formula the Encyclopædia has a misprint.]

But all that and immensely more had been given by John Bolyai in 1823 and by Lobachevski in 1826, and published in 1829, while as our authors themselves say, "Gauss published nothing on the theory of parallels."

Then comes the most offensive clause:

It is not known with certainty whether he influenced Lobachevski and Bolyai, but the evidence we possess is against such a view.

But it *is* known that he did *not*, and the evidence we possess against any such influencing is absolute and final. The very next sentence is the opening one of my Translator's Preface, 1891:

Lobachevski was the first man ever to publish a non-Euclidean geometry.

Of Bolyai's work is said:

¹ See chapter XVI., Pure Spherics, in my "Rational Geometry."

Its conception dates from 1823. It reveals a profounder appreciation of the importance of the new ideas, but otherwise differs little from Lobachevski's. Both men point out that Euclidean geometry is a limiting case of their own more general system.

[The Encyclopædia, by a misprint, has *as* for *is*.]

The works of Lobachevski and Bolyai, though known and valued by Gauss, remained obscure and ineffective until, in 1866, they were translated into French by J. Hoüel.

Bolyai was not translated until 1868. Not only were these known to Gauss, but I called attention to the very significant fact that the striking work of Saccheri, truly a non-euclidean geometry, was in the Göttingen library and freely accessible to Gauss during the years 1790-1800. See Gino Loria,² who says of Gauss:

Ignoto fino a qual punto egli siasi spinto nella nuova via, come è ignoto se egli abbia ricevuta qualche ispirazione dall' opera del Saccheri che esisteva a Göttinga negli anni 1790-1800 (essendo segnata con un asterisco nella *Bibliotheca mathematica* del Murhard).³

If figures are to be freely movable, it is necessary and sufficient that the measure of curvature should be the same for all points and all directions at each point. Where this is the case, it *is* the measure of curvature. . . .

This *it* should be *if*.

If *a* be positive, space is finite, though still unbounded, and every straight line is closed—a possibility first recognized by Riemann.

This, as it stands, is a mistake. On page 24 of von Staudt's "Geometrie der Lage" (1847) we read:

Eine Gerade erscheint hiernach . . . als eine geschlossene Linie.

The possibility first recognized by Riemann is that straight lines may be finite.

On page 729 occurs the long dead phrase "anharmonic ratio," now happily superseded everywhere by Clifford's "cross ratio."

² Il passato ed il presente delle principali teorie geometriche. Terza edizione, 1907, pp. 286-287.

³ Osservazione fatta dall' Halsted nell' articolo "The Non-Euclidean Geometry Inevitable" inserito in *The Monist*, July, 1894.

It is explained in section VII. in what sense the metrical geometry of the material world can be considered to be determinate and not a matter of arbitrary choice. The scientific question as to the best available evidence concerning the nature of this geometry is one beset with difficulties of a peculiar kind. We are obstructed by the fact that all existing physical science assumes the Euclidean hypothesis. This hypothesis has been involved in all actual measurements of large distances, and in all the laws of astronomy and physics. The principle of simplicity would therefore lead us in general, where an observation conflicted with one or more of those laws, to ascribe this anomaly, not to the falsity of Euclidean geometry, but to the falsity of the laws in question. This applies especially to astronomy. . . . But astronomical distances and triangles can only be measured by means of the received laws of astronomy and optics, all of which have been established by assuming the truth of the Euclidean hypothesis. It therefore remains possible that a large but finite space constant, with different laws of astronomy and optics, would have equally explained the phenomena. We can not, therefore, accept the measurements of stellar parallaxes, etc., as conclusive evidence that the space constant is large as compared with stellar distances.

Finally, it is of interest to note that, though it is theoretically possible to prove, by scientific methods, that our geometry is non-Euclidean, it is wholly impossible to prove by such methods that it is accurately Euclidean. For the unavoidable errors of observation must always leave a slight margin in our measurements. A triangle might be found whose angles were certainly greater, or certainly less, than two right angles; but to prove them *exactly* equal to two right angles must always be beyond our powers.

This I have been publishing for the past 35 years in articles some 77 of which, not counting translations, Sommerville has registered in his Bibliography of non-euclidean geometry, 1911. But just here a former pupil of mine, Dr. R. L. Moore, has gone beyond his teacher. His results seem to be unknown to the Encyclopædia, though I called attention to them in SCIENCE, October 25, 1907, under the "scare" heading, "Even Perfect Measuring Impotent."

In the brief bibliography appended to this

section VI., I notice a number of errors. In the title of Engel's book the *y* should be *ij*. In the title of Dehn's article, the word *Legendarischen* should be *Legendre'schen*. In the title of Barbarin's book the capital G and capital E should be lower case letters, and the hyphen should be omitted.

In the title of Bonola's book the capital E should be lower case.

In the title of the article by E. Study the nicht-Euklidische should be Nicht-Euklidische. This title upon a pamphlet of 97 pages [Greifswald, 1900] is *Über Nicht-Euklidische und Linien-Geometrie*.

In the title of Beltrami's article given on page 728, note 3, the g should be a capital in *Geometria* and the E lower case in non-euclidean. In note 4, page 725, nicht-Euklidischen should be nichteuklidischen. In note 1, page 727, nicht-Euklidische should be nicht-euklidische.

The final heading, VII., is *Axioms of Geometry*, under which it is said:

The second controversy is that between the view that the axioms applicable to space are known only from experience, and the view that in some sense these axioms are given *a priori*.

Both these alternatives are wrong. These axioms are assumptions, belonging to what I have treated under the title "The Unverifiable Hypotheses of Science," in *The Monist*, October, 1910.

The cruder forms of the *a priori* view have been made quite untenable by the modern mathematical discoveries. Geometers now profess ignorance in many respects of the exact axioms which apply to existent space, and it seems unlikely that a profound study of the question should thus obliterate *a priori* intuitions. . . . The enumeration of the axioms is simply the enumeration of the hypotheses of which some at least occur in each of the subsequent propositions.

On page 732, line 14, the comma after the word "however" is a misprint, and should be deleted.

Geometry with the assumption: Of any three points of a straight there is always one and only one which lies between the other two, Whitehead calls "descriptive geometry," a

horrible piece of nomenclature, which no one should adopt, since this name belongs to the system of Monge, 1794, for representing solids in a plane, though also used by Sylvester for a geometry excluding all notions of quantity, such as my "Synthetic Projective Geometry."

The article proceeds to the simplest statement of all. Descriptive Geometry is then conceived as the investigation of an undefined fundamental relation between three terms (points); and when the relation holds between three points A, B, C , the points are said to be "in the [linear] order ABC ."

O. Veblen's axioms and definitions, slightly modified, are as follows:

1. If the points A, B, C are in the order ABC , they are in the order CBA .

Dr. R. L. Moore (October 26, 1907) says this may be divided into parts, 1, inserting "distinct" before "points"; and 1, inserting "not all distinct," after "points."

2. If the points A, B, C are in the order ABC , they are not in the order BCA .

3. If the points A, B, C are in the order ABC , then A is distinct from C .

4. If A and B are any two distinct points, there exists a point C such that A, B, C are in the order ABC .

Dr. R. L. Moore modifies this to 4' by inserting "different from A and from B ," before "such." Then follow a definition, Def. 1, and axioms 5, 6, 7. Both in this definition, and in axiom 5 the shocking misprint occurs of using the symbol \pm , "plus or minus," for the symbol \neq , "is not equal to."

Dr. R. L. Moore had already in 1907 surprisingly simplified this set of assumptions by proving that 1, is a consequence of 2 and 5 and Def. 1, while 1, and 3 are both consequences of 2, 4', 5, 6, 7 and Def. 1.⁴

Lobachevski [or Bolyai] constructed the first explicit coherent theory of non-Euclidean geometry, and thus created a revolution in the philosophy of the subject. For many centuries the speculations of mathematicians on the foundations of geometry were almost confined to hopeless attempts to prove the "parallel axiom" without the introduction of some equivalent axiom.

⁴ *Trans. Amer. Math. Soc.*, Vol. XIII, No. 1, pp. 74-76.

In the Bibliography, Whitehead says of Lobachevski:

His first publication was at Kazan in 1826.

This is a mistake. In 1836 in his "Introduction to New Elements of Geometry," of which I was the first to publish a translation,⁵ he says:

Believing myself to have completely solved the difficult question, I wrote a paper on it in the year 1826: "Exposition succinète des principes de la Géométrie, avec une démonstration rigoureuse du théorème des parallèles," read February 12, 1826, in the séance of the physico-mathematic faculty of the University of Kazan, but nowhere printed.

No part of this French manuscript has ever been found. The latter half of the title is ominous. For centuries the world had been deluged with rigorous (!) demonstrations of the theorem of parallels.

Saccheri's book of 1733, containing a coherent treatise on non-euclidean geometry, of which I published the first translation, ended with another "démonstration rigoureuse du théorème des parallèles." If Saccheri had realized (as Father Hagen writes me he did) the pearl in his net, he could, with the new meaning, have retained his old title, Euclides ab omni naevo vindicatus, since the non-euclidean geometry is a perfect vindication and explanation of Euclid.

But Lobachevski's title is made wholly indefensible. A new geometry, founded on the contradictory opposite of the theorem of parallels, and so proving every demonstration of that theorem fallacious, could not very well pose under Lobachevski's old title. He himself never tells what he meant by it, never tries to explain it.

The title of Engel's book already given erroneously in the Bibliography under VI., is now, under VII., given again with the former and two additional errors.

After Riemann we see *Gesamte Werke* instead of *gesammelte Werke*.

In the title of Poncelet's work, on page 736, an accent is omitted which is given in the

⁵ "Neomonic Series," Vol. V., 1897.

same title on page 676, where on the other hand the main word of the title is omitted.

The Beiträge of von Staudt appeared in two parts, the first in 1856, the second in 1860. How could Whitehead have made the mistake of calling this second part a "3rd ed."?

GEORGE BRUCE HALSTED

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PEARL AND JENNINGS ON ASSORTATIVE CONJUGATION IN THE PROTOZOA

In general, the scientist's investigations receive the recognition they deserve from his fellow workers. This is true because the bulk of research consists in the working out of details in a scheme already stamped with authority. It is the unexpected, fundamentally new or truly brilliant result upon which the doctors disagree.

One of the best illustrations is a paper in *Biometrika* for February, 1907. In the demonstration of the existence of an assortative conjugation or homogamy in *Paramecium* analogous to the assortative mating previously found by Pearson in man, Pearl seemed to some of us to have struck a rich vein hitherto passed over by all prospectors. Others thought differently. Pearl's assays were discredited. In America, at least one review was declined. In England, J. J. Lister illustrated¹ by Pearl's paper his warning to biometricians to be sure they have a problem which is "sound from the standpoint of biology before bringing a formidable mathematical apparatus into action for its investigation."

Open criticism like that of Lister was more easily met² than the general indifference largely attributable to the *odium mathematicum*. This is now in a fair way to be overcome by the results being announced by Jennings. If these, in their turn, are being received by zoologists with but lukewarm enthusiasm, the fact indicates merely that the work is in advance of its time.

His recent study of conjugation in *Para-*

¹ Lister, J. J., *Nature*, Vol. 74, pp. 584-585.

² Pearson, K., *Nature*, Vol. 74, pp. 465-466, 608-610, 635, 1907.

³ Jennings, H. S., "Assortative Mating, Variability and Inheritance of Size in the Conjugation

mecium must be considered in comparison with Pearl's pioneer paper.⁴

a. *Differentiation of Conjugants in Type and Variability*.—The general belief that conjugants are on the average smaller than non-conjugants is quantitatively substantiated. In eleven "pure lines" Jennings found conjugants to be from about 4 to nearly 14 per cent. smaller than the non-conjugants. In "wild" cultures, or in a mixture of differentiated pure lines, the mean for conjugants may be higher because only the large pure line is in conjugation. On the other hand, the conjugants may be abnormally small, 30 per cent. less than the non-conjugants, because only the smaller of the lines in the mixture is in conjugation.

Both absolutely and relatively, the conjugants are less variable than the non-conjugants. The difference in variability may be slight but generally it is large, for the conjugants are on an average about 33 per cent. less variable (relatively) than the non-conjugants.

The possible causes of this reduced variability are discussed. Lister's "Gametic Differentiation" is dismissed. Pearl's conclusion that equalization of individuals (undifferentiated or proconjugants) during the process of conjugation can not account for the lessened variability is confirmed. Jennings's conclusion, supported by abundant evidence, is that the low variability of conjugants is fully accounted for by the fact that conjugation does not occur till a certain growth stage has been reached, and does not occur in the largest individuals—the measurable variability of *Paramecium* being largely a growth phenomenon. Thus, the conjugants represent a definite and rather limited growth stage, the exclusion of both the larger and

of *Paramecium*," *Journ. Exp. Zool.*, Vol. 11, pp. 1-134, July, 1911.

⁴ Pearl, R., "A Biometrical Study of Conjugation in *Paramecium*," *Biometrika*, Vol. 5, pp. 213-297, 1907.

⁵ The offspring of a single individual reproducing by fission has been called by Jennings a "pure line." In retaining the term here nothing more is implied than guaranteed purity of descent.

smaller individuals resulting in a pronounced reduction in variability. The growth factor may be in wild cultures supplemented by racial heterogeneity.

b. The Existence of an Assortative Mating.—Pearl's conclusion that there is a real assortative mating in *Paramecium* is backed up in every point by Jennings's more detailed study. Large individuals conjugate with large, small with small. Pearl's five series gave positive values of $r = .430$ to $r = .794$. Jennings's eight "wild" cultures of unknown racial composition all gave positive correlations of $r = .245$ to $r = .507$.

In twelve lots of conjugants from "pure races" with correlations ranging from $r = -.193$ to $r = .507$, there are ten positive and only two negative constants—both based on very small numbers and not statistically trustworthy with regard to their probable errors. The average of the twelve is $r = .251$. The correlation after separation of the pairs, is demonstrated to be greater than that determined on individuals which are united.

c. The Causes of the Assortative Mating.—Unquestionably, therefore, there is a real assortative conjugation. The redemonstration of the existence of a correlation between conjugants and the proof that it is not merely the result of heterogeneous cultures with only certain constituents in conjugation at one time is followed by a magnificent experimental-statistical analysis of the possible underlying factors. Equalization during mating, change of size during union, differential contraction due to killing fluid, environmental heterogeneity in the culture, are subjected to observation, experiment, measurement and statistical analysis. The specific results interest primarily the protozoologist. The broad and well-established conclusion is that the chief source of the correlation is, as Pearl five years ago maintained in *Biometrika*, a real assortative mating (larger individuals tending to conjugate with larger, smaller with smaller) arising in the fact that individuals must be of a certain degree of similarity in size to "fit."

d. The Evolutionary Significance of (a)-(c).—In connection with physiological differences resulting in different times of conjugation demonstrated by Jennings, the assortative conjugation is clearly a factor of the highest importance in the physiological isolation of the diverse races of *Paramecium*.

Apparently, the smaller size and lower variability of the conjugants have not a selective influence in maintaining the type of the population. The smaller extremes are, for the most part, younger than the conjugants, while the larger non-conjugants themselves conjugate after a few fissions. Moreover, the offspring of conjugants increase in size and in variability until they equal (or, in size exceed) the non-conjugants. Ex-conjugant offspring of individuals separated before completing conjugation.

Finally, the questions concerning the origin of heritable variations through conjugation within the "pure line," inextricably bound up as they are with the problem of the significance of conjugation, are reserved for a later paper. We are told, however, that heritable variations do, though rarely, arise as the result of conjugation within the "pure race."

Important as are the biological results of these two papers, their greatest value lies, not in concrete facts, but in their demonstration of the value of a widely applicable method. Let us hope they are only the beginning of the attack upon the many problems of morphology, physiology and genetics of the microorganisms which the biometric methods applied by Pearl and Jennings render possible.

J. ARTHUR HARRIS

"THE PASSING OF THE SLIME-MOULD"

ON the first page of a late number of SCIENCE, April 13, appears the heading of a brief note entitled "The Passing of the Slime-moulds," by Professor C. E. Bessey. One who reads no farther, having in mind such titles as "The Passing of the Buffalo," "The Passing of the Chinese Empire," etc., might possibly infer that the slime-moulds were doomed

to speedy disappearance if not already gone. But such would be a serious error: the case is not so bad as that. These beautiful organisms were never more abundant than, nor did they ever receive such intelligent attention as, at the present moment. If the reader will leave the title-page and turn to the article itself he may, by reading a sentence or two, perhaps conclude that the "passing" in question is limited to the transit of thoughts about slime-moulds in the mind of our honored colleague during some thirty years. This is of course a matter of interest. We are glad to learn Professor Bessey's view even if inconstant, concerning any topic whatsoever. But we are still too hasty of conclusion. The "passing" intended is something different yet. Read to its conclusion the article in question would have us know that, in the judgment of the author, slime-moulds have finally passed from botany to zoology, have ceased to be plants (?) and have become animals—good riddance to them! Now in so much as our colleague esteemed does not at all trouble himself to define for us a plant or even an animal, the reader is left wondering; there rises the unbidden query: if we do not *know* what they are, why not let them alone, at least until we do know something definitive?

It appears, however, from the article, that DeBary, some half century ago, concluded the slime-moulds were not plants. It appears further that nothing has been added to DeBary's argument until the recent appearance in the *Encyclopædia Britannica* of an article on the *Mycetozoa*, where these are set forth as animals for the mere reason that the author of the contribution so esteems them. Professor Bessey agrees. The whole thing is a matter of opinion; each of us, so far as stated reasons go, may think as he will;—and there you are!

But since the encyclopedia article has been forthright the cause provocative in the present instance, it may be worth our while to note for a moment the inspiration of that particular essay, that we may better realize the full weight attaching to the opinion so consoling to our Nebraska author.

The writer of the 11th-edition article bears a distinguished name. He is a zoologist, a collaborator of Professor E. R. Lankester for whose "Treatise on Zoology," now appearing, the younger man wrote a chapter on the *Mycetozoa*. For the "passing of the slime moulds" so far, therefore, we are indebted to the English professor, and it is worth while reading the introduction to what is to be his masterpiece, no doubt, to his "Treatise," in order to completer information at first hand.

This introduction to have *raison d'être* at all must evidently show something new. It is fair to state that the only novelty discoverable, aside from a multitude of unnecessary and hybrid terms, consists in the amount of botany offered, both in the introduction and in volume one. In the introduction the independent life of the green plant is emphasized at length, as matter heretofore strange to the zoological reader. The "subtle process" by which green plants take up N in the form of *ammonia* will come as information to botanists as well; while the statement that the animal depends for food upon "hydrocarbons" ought to be news even to zoologists.

That the earliest plants are to be traced to flagellate colony-building protozoa, similar to the *Volvocineæ*—here reckoned animals, of course—is also a contribution to botany deserving grateful recognition. But it is admitted that certain organisms "devoid" of chlorophyll are plants. Here belong "fungi, bacteria and a few others."

Autonomous fungi and the saprophytes depend for their food on the products supplied to them by the chlorophyll-holding cells of green plants.

Finally, the summary of zoological wisdom in this remarkable discussion appears in the following elegant sentence:

The colorless or greenless plants are descended from green chlorophylligerous ancestors: mouthless, gutless animals are descended from mouth-bearing, gut-hollow animals.

Now as above stated, the encyclopedia man prepared a chapter on *Mycetozoa* to follow in Vol. I. this erudite introduction. The slime-moulds are protozoa and come in for the present, until better accommodations are at

hand, between the *Heliozoa* and the *Radiolaria*. This, of course, need make little difference. The slime-moulds are "mouthless and gutless" and should go anywhere with that set. From just which, however, of the "mouth-bearing, gut-hollow" creatures such graceful forms as *Arcyria* and *Lamproderma* have descended will no doubt be made clear on some future page!

Such is the sort and kind of finished scholarship with which it is now sought to align American botanists.

But really does it much matter where these things are placed? For 150 years they have been handled by the botanist. If they are now to go to the zoologist, or the chemist, he must show some reason for his claim. Some day, refined research, perhaps by methods not now devised, will show more clearly lines of descent and so of genetic kinship. That day is not here yet—so far, at least, as is to be learned from authorities herein cited.

Meantime, it may be said in conclusion, the great collections on which the Oxford professor and his pupils have so gratuitously toiled, still occupy probably an honored alcove in the *herbarium* of the British Museum.

T. H. MACBRIDE

IOWA CITY,

April 13, 1912

SCIENTIFIC BOOKS

Meteorology, a Text-book on the Weather, the Causes of its Changes and Weather Forecasting, for the Student and General Reader. By WILLIS ISBISTER MILHAM. The Macmillan Company. 1912.

As the author of this latest treatise on meteorology is a most popular professor of astronomy in Williams College it is natural that this book shall bear all the characteristics of an admirable text-book for class use. It is also intended for the general reader. It starts at the beginning and must be intelligible to all, but it has abundant references to current literature for the use of those who wish to study further. The author has not attempted the history of the science, nor the relations of climate to disease or plants, nor has he

laden his pages with heavy mathematical work nor with a dozen other special items that would be included in an encyclopedic treatise. Professor Milham's book is simply an enlargement of the lectures which he has been giving for the last eight years in Williams College which aims to give its students a broad education in languages and sciences that have to do with our every-day life. The genial generosity of the author is shown by his painstaking acknowledgment of every authority from whom he quotes and one might imagine the book to be a compilation were it not for the many good ideas originating with the author. As a popular text-book it is admirable and fills a want distinct from that which is satisfied by the excellent work of Davis. After four hundred pages devoted to the atmosphere and the weather bureaus the author adds a hundred pages, as part two, devoted to the climate, the floods, electric, optic and acoustic phenomena.

The great utility of reliable forecasts has undoubtedly always been an incentive to all mankind and throughout all ages to apply our crude scientific knowledge to the study of the atmosphere, but since the days of Galileo the love of knowledge for its own sake—the love of research into the hidden things of nature has been a characteristic of civilized man. The conflict between darkness and light, the contest between superstition and intelligence, the fight between conservatism and progress has nowhere been so persistent as during the past forty years and in the field of meteorology. Professor Milham is quite correct in saying that there is no subject wherein ignorance and superstition are more nearly universal than in connection with the weather. Perhaps we can not blame the well-educated citizens for a certain amount of ignorance since so little is taught about meteorology either in high schools or colleges. Apparently another century must elapse before courses of laboratory experimentation have been devised for use in our higher schools of science.

Our subject begins with the constitution of the atmosphere considered as a mixture of several gases and vapors; these are warmed by

the sunshine and cooled by the radiation of heat; the upper layers of the atmosphere have both heat and moisture carried upward into them by convection, namely, by air that ascends from near the earth's surface; on the other hand the lower atmosphere is slightly cooled by the descent of an equivalent mass of the upper air. Of course radiation of heat from the atmosphere and the earth outwards goes on continuously, whereas convection is spasmodic; hence, the distribution of temperature is a regularity that is modified by many irregularities. The annual and the diurnal periods and the irregular variations of heat are appreciated by every one as is also its diminution with altitude. The barometric gradient is generally regarded as the cause of the motions of the atmosphere, but the rotation of the earth on its axis modifies these winds in such a way that northerly winds become northeast and southerly winds become southwest and so on around the circle. Of course the atmospheric pressure has its regular annual and diurnal variations and its irregular ones also, as well as its diminution with altitude. The regions of high pressure on the earth's surface are also regions of descending dry and dense air, whereas the regions of low pressure are those toward which the air is blowing and are the ordinary storm centers. The general circulation of the atmosphere is maintained by such barometric differences far above the earth's surface as well as at sea level: these are complicated with the large differences of the highs and lows of the barometric pressure that maintain our storm areas. The paths of these areas are shown by Milham in small maps prepared by several different persons—Bigelow, Van Cleef, Bebbler, Loomis, Russell. The attempt to predict the path of any area of high or low pressure is the fundamentally difficult problem of the forecaster and is one to which considerable attention is given in Professor Milham's book. The volume is illustrated by 157 illustrations and fifty charts and a number of numerical tables. A brief summary shows that Milham's meteorology is a work destined to be eminently useful, both to the teacher and to

the general reader. The publishers have spared neither money nor pains in order to make this beautiful volume acceptable to the author, the teacher and the student.

C. A.

Probleme der physiologischen und pathologischen Chemie. Fünfzig Vorlesungen über neuere Ergebnisse und Richtungslinien der Forschung für Studierende, Aerzte, Biologen und Chemiker, von Dr. Otto von FÜRTH, A. Ö. Professor für angewandte medizinische Chemie an der Wiener Universität. I. Band, Gewebeschemie. Leipzig, Verlag von F. C. W. Vogel. 1912. Pp. xv + 634.

This is neither a systematic text-book, an encyclopædic compilation of facts, nor a mere epitome of current theories or methods—it is quite different from other recent publications in this field of science. Physiological chemistry has been the subject of an exceptionally large number of useful handbooks and comprehensive monographs on special topics, all published in very recent times and useful as works of reference. Here at length is a book which can not only be "tasted" or "swallowed," but even "chewed and digested," according to the Baconian classification. Assuming a familiarity with at least the elements of biochemistry on the part of every reader and making no pretense to cover the field with uniform completeness or comprehensiveness in every chapter, Professor v. Fürth has furnished a readable volume of refreshing novelty.

We are in danger, in present-day science, of becoming the slaves of system. These new lectures break away from some of the current tradition in respect to form and appeal to him who is not so much in search of organized literature as of inspiring viewpoints. The justification for this series of essays on the accomplishments and tendencies of the chemical physiology of these days—essays unhampered by the conventional text-book requirements—is well expressed by the author.

Ich vermag mich niemals eines Gefühles von Neid zu erwehren wenn ich zum Beispiel Briefe

von *Liebig*, *Wöhler* oder *Berzelius* lese und sehe, wie für diese Glücklichen jede wissenschaftliche Publikation ein Ereignis war. Mit welcher Liebe wurde alles, auch wenn es nur wissenschaftliche Kleinarbeit war, aufgenommen, mit welcher Freude wieder gelesen und überdacht. Wir laufen Gefahr, durch die Masse literarischer Produktion schliesslich das naive Vergnügen am Neuen einzubüssen und der Neugierde verlustig zu werden, die jedes ursprüngliche Individuum, ob jung oder alt, dem Unbekannten entgegenbringt und die schliesslich die Seele jeder echten Naturforschung ist. Und wenn heute in einem Fache, wie es die *Biochemie* ist, der Fachmann im Schweisse seines Angesichtes eben noch imstande ist, sich über die Literatur in ihren wichtigsten Erscheinungen einermassen zu orientieren, ist dies für den Fernerstehenden bereits längst ein Ding der Unmöglichkeit geworden.

The titles of the individual lectures are too diverse to be quoted here in detail. The treatment throughout is animated by the viewpoint of the physiologist, rather than the chemist. Chemistry is made to elucidate biological functions. The lectures can not fail to interest pathologist, therapist and surgeon as well as physiologist; for their problems are considered in common in a truly biological spirit well exemplified in a chapter on the thyroid. In a chapter on the kidneys, for example, the theories of secretion, the problems of uremia, the inadequate status of our knowledge of eclampsia, transplantation experiments, etc., are interwoven into suggestive relationships reminding one of how much still awaits solution. The critique of the author obviously can not always be equally forceful or correct; how trenchant it may at times become is illustrated by v. Fürth's comments in relation to eclampsia:

Für den Begriff eines "urotoxischen Koeffizienten," so schön und gelehrt dieser Name auch klingen mag, vermögen wir seinem Erfinder mit bestem Willen nicht dankbar zu sein.

It is unnecessary to proceed far in these lectures to discover that the author is something more than a compiler. He has studied physiological problems in the laboratory; and, as might be expected, the expert familiarity with certain phases of the subject betrays

itself advantageously in many places. For this reason, too, not all of the topics are treated with equal success. It is as gratifying as it is uncommon to find, in a European book, a thorough appreciation of the work of American investigators along physiological lines.

To one who enjoys the historical aspects of science the lectures will afford many entertaining reminders. There is a "subjective" tendency manifest throughout, which occasionally goes to the extreme of hyperappreciation. The personal factor and individuality of the treatment crop out frequently in delightful "touches," a few of which may be quoted here. Speaking of the prolongation of life and the "sour milk" therapy of Metchnikoff:

Ist es doch das gute Recht der Menschheit, sich des grossen Allbezwingers mit allen ihr zugänglichen Mitteln zu erwehren, und es wäre sicherlich sehr erfreulich, wenn ein so einfaches Pharmakon, wie vergohrene Milch sich ihr als wirksames Kampfmittel erweisen sollte (p. 44).

For intermediary metabolism, we read, passt ein Bild, das einst ein geistvoller Mathematiker auf die Integralrechnung angewandt hat, um die unergründlichen Tiefen derselben seinen Hörern begreiflich zu machen. Er sagt, sie gleiche einem Meere, an dessen Ufern der Fischer immerhin das sammeln mag, was aus der Tiefe nach der Oberfläche dringt; doch vermag keines Menschen Auge die ganze Daseinsfülle zu ergründen, welche die abysstischen Tiefen erfüllt (p. 46).

Note the attitude toward exploded theories:

Es dürfte aber vermutlich noch eine ganze Weile dauern, bis die Uroleucinsäure aus der physiologischen Chemie verschwunden sein wird; denn die Biochemiker zeichnen sich meist durch eine besondere Pietät gegenüber den Irrtümern ihrer Vorgänger aus. In der "reinen" Chemie pflegt man kürzeren Prozess zu machen und hält es nicht für nötig, in jeder Abhandlung die ganze Kette überwundener Irrtümer früherer Generationen von neuem abzuhaspeln (p. 52),

or again:

Es ist stets eine missliche Sache, wenn man über unklare Dinge eine klare Auskunft geben soll (p. 67).

Commenting on the superiority of certain

synthetic over the older natural products, he writes:

Ich fürchte fast, es würde manchem Teilstücke der Herrlichkeit klassischen Altertums ebenso ergehen, wenn man es mit der Exaktheit einer chemischen Synthese vor unseren Augen neu erstehen lassen könnte. Von dem alten Märchenglanze würde vielleicht nicht allzuviel übrig bleiben (p. 76).

The future possibilities of protein synthesis are introduced with these words:

Sowohl für junge Menschen als auch für junge Wissenschaften gehören Ideale zu den notwendigen und gesunden Lebenselementen, da ihnen die Fähigkeit innewohnt, latente Kräfte zu mobilisieren und nützlichen Zielen dienstbar zu machen, wenn auch die Unerreichbarkeit streng genommen zum Begriffe eines Ideales mit dazu gehört (p. 96), whereas the older attempts are dismissed thus:

Dass wir auf diesem und auf ähnlichen Wegen zu wirklichem echten Eiweiss gelangen könnten, ist wohl nicht viel wahrscheinlicher, als wenn jemand einen Haufen Lettern in einem Sacke durcheinander mischen, sodann auf den Tisch ausschütten und nun hoffen möchte, dass dieselben sich zu einem schönen Gedichte gruppieren würden (p. 97).

That there is no attempt to hide our ignorance in certain fields is indicated in connection with internal secretion,

ein viel missbrauchtes Schlagwort, welches im Laufe des letzten Dezenniums zu einer gewaltigen Popularität gelangt ist. Dasselbe bezieht sich auf die Funktion einiger Organe, deren physiologische Rolle und Bedeutung, ungeachtet eines grossen Aufwandes von Mühe und Arbeit, in tiefes Dunkel gehüllt ist. "Denn eben wo Begriffe fehlen, da stellt ein Wort zur rechten Zeit sich ein;"—so sprach einmal ein weiser Mann, der zwar von "inneren Sekretionen" noch nichts ahnte, dafür aber über manche andere Dinge um so besser Bescheid wusste (p. 404).

The sources of the literature are indicated in a comprehensive way and the progress of research has evidently been followed up to very recent months. There is, as a rule, no irritating wealth of details; yet the essential steps in important reactions, such as the synthesis of suprarenin, are reviewed with painstaking accuracy. A second volume on metabolism is promised soon.

The publication of the lectures was the outcome, the author tells us, of a desire

meine eigene Freude an biochemischem Suchen und Erkennen anderen, die danach Verlangen tragen, zu übermitteln und auf diesem Wege meiner Wissenschaft zu dienen.

In this Professor v. Fürth has succeeded.

LAFAYETTE B. MENDEL

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The Lower Cretaceous Deposits of Maryland.

By WILLIAM BULLOCK CLARK, ARTHUR B. BIBBINS, EDWARD W. BERRY and RICHARD S. LULL. Maryland Geological Survey. 1911. Pp. 1-622, pl. I.-XCVII.

This volume, the fourth of a series of exhaustive reports dealing with the systematic geology and paleontology of Maryland, is devoted to the Lower Cretaceous and is a distinct and invaluable contribution to the history of the Atlantic coastal plain geology of which the Maryland section may be taken as the type. The first hundred pages are devoted to the coastal plain region of the state and comprise a description of its physiographic features and a briefer statement of the Cretaceous, Tertiary and Quaternary formations, followed by a more detailed account of the areal distribution, lithologic character, stratigraphic and structural relations and organic remains of the three Lower Cretaceous formations involved. These, according to the nomenclature adopted, are, in the order of their superposition, the Patuxent, the Arundel and the Patapsco formations, together comprising the Potomac group. An especially valuable part of this portion of the volume is the historical review of opinion and the bibliography, for, be it known, the geology of Maryland has been the subject of much discussion and difference of interpretation. For example, the Patuxent and Arundel formations, on the basis of their contained vertebrates, were held by Marsh to be of Jurassic age, while the abundant plant-remains argued indisputably for their Lower Cretaceous age, a conclusion to which Professor Lull, who has reexamined the vertebrate material, has also come.

The paleontology fills the remaining five sixths of the volume and comprises reports on the Molluska by Clark, the Vertebrata by Lull and the Plants by Berry. The molluscs are unimportant, consisting of only five species, all new, four of which are from the Arundel and one—a *Unio*—from the Patapsco. They are of little or no value in correlation.

The vertebrate fauna—found only in the Arundel—is much larger and consists of seven genera of dinosaurs, a crocodile, at least one turtle, and a ganoid fish. In discussing the affinities of the dinosaurs Professor Lull compares them with the Morrison of the west and the Wealden and Jurassic of Europe, concluding that “the weight of evidence would seem to place this fauna beyond the Jurassic into the beginning of Cretaceous times.” As the Arundel reptiles are closely related to, if not in some cases actually identical with, those from the Morrison of Colorado, their bearing on the age of the latter is of importance.

The major portion of the volume is devoted to the elaboration of the fossil flora by Mr. Berry. As a preliminary to the correlation of the Potomac flora he devotes a chapter to the “Lower Cretaceous Floras of the World,” in which is reviewed the plants of this age in Switzerland, Portugal, France, England, Belgium, Germany, Saxony, Africa, Peru, Japan, China and Spitzbergen, as well as the several approximately contemporaneous deposits in this country. Complete lists of the species occurring at each locality are given, and while no attempt has been made to revise the nomenclature or determinations, they furnish an exceeding valuable basis for correlative and stratigraphic comparisons. Following this is a chapter on the “Correlation of the Potomac Formations.” In this it is shown that the Patuxent and Arundel formations on the basis of their contained floras are essentially a unit of early Cretaceous age whose affinities all lie with the floras which preceded them, while the Patapsco, which was separated by a long time interval, has its strongest relations with the floras which followed it. The conclusion is reached that the Patuxent and

Arundel formations “considered as a unit represent all except possibly the earliest part of the Neocomian and all of the Barremian of standard European sections.” In this country it is believed to correspond in whole or in part with the Trinity of Texas, the Lakota of the Black Hills, the Kootenai of the Rocky Mountain region and the Cretaceous portion of the Knoxville of the Pacific Coast. The Patapsco is correlated with the European Albian and with the Fuson of the Black Hills. It is chiefly remarkable for the fact that it appears to have witnessed the introduction of the dicotyledons.

Over four hundred pages and seventy-five plates are devoted to the elaboration of the flora, which, according to Mr. Berry, comprises 144 species distributed among the several groups as follows: Filicales 43, Lycopodiales 1, Equisetales 2, Cycadophyta 33, Ginkgoales 1, Coniferales 29, Angiospermæ 25, of unknown systematic position 10. The treatment throughout has been conservative and rational, and has been based on all of the original material as well as a vast amount of recently and carefully collected material, with the result that the number of recognized species has been greatly reduced. Thus, Fontaine referred 42 species of ferns to the living genus *Thysopteris*, but these have been reduced to 5 and all referred to *Onychiopsis*. The number of species of *Cladophlebis* has been much reduced, as they have in the genera *Abietites*, *Sphenolepis*, *Arthrotaxopsis*, and especially *Sequoia*. A new generic type of fern, thought possibly to be referable to the Matoniaceæ, has been established for certain fronds of medium or large size and pseudodichotomous habit. Another fern, originally referred to *Baieropsis*, is shown clearly to be a member of the Schizaceæ.

However, most biologic interest centers in the angiosperms, since they are as old as any of which we have definite knowledge. From the original descriptions and roughly prepared figures, it appeared that they were crude and archaic as befitted their first appearance, but with newer and better material and improved methods of reproducing them, they are seen to

be highly organized and surprisingly "modern" in aspect, thus showing that our knowledge of the actual starting point for this now dominant group is still imperfect. Mention may be made of a few of the more interesting forms. A small *Sagittaria*-like leaf is described under the new generic name of *Alismaphyllum*. What appears to be a fruiting sedge is included under *Cyperacites*, while under the name of *Plantaginopsis* is figured a plantain-like leaf and fruit possibly belonging to the Xyridales, which completes the list of monocotyledons. The dicotyledons are included under *Populus*, *Populophyllum*, *Nelumbites* (a very *Nelumbo*-like leaf formerly referred to *Menispermities*), *Sapindopsis*—the most abundant and important dicotyledonous plant of the time—*Celastraphyllum*, a form-genus suggesting the Celastraceæ, *Sassafras*, quite closely approximating the living form, *Araliaphyllum* and *Ficophyllum*, form-genera recalling *Aralia* and *Ficus* respectively, and a few others that are without very clearly understood living affinities. Altogether, the elaboration of the Lower Cretaceous floras of Maryland is of a high order, and Mr. Berry is to be congratulated on the completion and publication of the work which must long remain as a model of its class.

F. H. KNOWLTON

Woodland Idyls. By W. S. BLATCHLEY. Indianapolis, Ind., The Nature Publishing Co. 1912. Pp. 242.

Mr. Blatchley has again published a nature book, interesting, instructive, enjoyable. Just the kind of a book to take out on a summer vacation to impart the love of nature and her creatures and teach one the value of simple things. It is a chronicle of several vacations spent in the fields and woods, camping at night in a tent, by day fishing, watching birds and insects, and taking notes on the happenings around him. Mr. Blatchley is qualified to speak knowingly and scientifically of nature's secrets, by long years of investigation in various phases of zoology and botany. The specialist will find here many little notes on the habits of birds, fish, turtles, small mam-

mals and insects fresh from the mind of a careful observer. Like a clear, sweet, woodland brook, there runs through all a philosophic, yet optimistic strain of adaptation of human needs to the simplicity of nature.

N. BANKS

The Evolution of Animal Intelligence. By S. J. HOLMES. New York, Henry Holt. 1911. Pp. iii + 296. \$2.75.

Professor Holmes gives a rather popular presentation of some of the recent work in animal behavior. He does not pretend to make his treatment of the field of behavior at all complete. The subjects he treats at some length are as follows: tropisms; behavior of protozoa; instincts and their origin; pleasure, pain and the beginnings of intelligence; types of intelligence in crustaceans, mollusks, insects, lower vertebrates and mammals. The final chapter is devoted to the study of the mental life of apes and monkeys.

While most if not all of these subjects have received more skilful treatment in the hands of Jennings, Mast, Washburn, Yerkes and Thorndike, Holmes gives a readable presentation of certain phases of behavior which will be of service to students beginning the study of comparative psychology. The book's value lies in the readiness with which it lends itself to pedagogical purposes.

JOHN B. WATSON

JOHNS HOPKINS UNIVERSITY

Butterfly Hunting in Many Lands: Notes of a Field Naturalist. By GEO. B. LONGSTAFF, M.A., M.D., Oxon. Longmans, Green & Co. 1912. Pp. xviii + 724, with sixteen plates, seven colored. Price, \$7.00 net.

The author describes this work as "an attempt, possibly a foolish one, to put into a readable form the technical diaries of a wandering entomologist, and to entomologists alone it appeals." The reviewer is inclined to agree. After a chapter on early reminiscences, Dr. Longstaff devotes nearly five hundred pages to notes on his captures from 1903 to 1910, during which time he visited Canada, certain of the West Indies, Panama,

northern South America, South Africa, Algeria, Egypt and the Soudan, India and Ceylon, China, Japan, New Zealand and Australia. He very evidently collected vigorously, both by eye and by net, not confining himself to butterflies, notwithstanding the title. In fact the majority of the illustrations in this part of the book as well as many of the notes concern other insects. These notes are largely simple records of captures, leavened somewhat by random remarks concerning them or his traveling experiences. In view of the large amount of ground covered in so short a time, the lists of species for given localities are naturally too incomplete to be important and they must certainly detract from the interest of the narrative for non-entomologists.

The last chapter is based upon two papers by the same author in the *Trans. Ent. Soc. London* and is a summary of bionomic notes made chiefly by Dixey and the author on butterflies. The odor of many species is described; mutilated specimens are listed as having escaped from foes; peculiarities of flight and resting attitudes, including the selection of harmonizing backgrounds, are discussed, and the conclusions are orthodox neo-Darwinian.

The appendix consists of a translation of twelve of Fritz Müller's papers on the scent-organs of Lepidoptera. Six of these were published in Portuguese in the *Arch. do Mus. Nat. do Rio de Janeiro* where they have been inaccessible to many. The translations are by E. A. Elliott and the introduction to the appendix is by Poulton. The collection and translation of these papers will be a great help to students and it is well that they be read in connection with Longstaff's observations. However only the last chapter (and not all of that) is necessary for this purpose, and it does seem unfortunate that the rest of the book was not bound separately.

F. E. LUTZ

THE TALKING DOG

EXTENSIVE comment has been made in the German and even in the American daily press

on the reported conversational ability of "Don," a German setter seven years old, belonging to the royal gamewarden Ebers at Theerhutte in Gardelegen. Numerous observers reported that he had a vocabulary consisting of eight words, which he could speak if food were held before him and the following questions propounded: "Was heisst du?" "Don." "Was hast du?" "Hunger." "Was willst du?" "Haben haben." "Was ist das?" "Kuchen." "Was bittest du dir aus?" "Ruhe." Moreover, he was said to answer categorical questions by "Ja" and "Nein"; and in reply to another question, to speak the name, "Haberland." Among others whom popular report mentioned as witnesses to this extraordinary ability of the dog was Mr. Oskar Pfungst, of the Psychological Institute of the University of Berlin, whose important tests on the horse of Herr von Osten, "Der Kluge Hans," have lately been published in English.¹ Mr. Pfungst had in fact investigated the behavior of the dog in collaboration with Professor Vosseler and Dr. Erich Fischer, keeping detailed memoranda on the tests, and making a number of phonographic records. Partly to clear up misapprehension of his own position and partly for the enlightenment of the serious general public, he gave out a brief popular report of his work,² a summary of which appears below.

Having proposed three definitions of speech: first, properly, as the use of vocal sounds to convey to the listener an idea experienced by the speaker; secondly, more loosely, as the production of vocal sounds learned by imitation, but used without knowledge of their meaning to the hearer; and thirdly, as the production of vocal sounds not imitative of human speech, having no meaning to the speaker, but producing in the hearer illusions of definitely articulated, spoken words, uttered to convey meaning—Mr. Pfungst then asks to

¹ Pfungst, Oskar, "Clever Hans." Translated by Carl L. Rahn. New York, Henry Holt & Company, 1911.

² "Der sprechende Hund," von Oskar Pfungst (Berlin), Sechste Beilage zur Possischen Zeitung, 27 April, 1911.

which class the speech of Don properly may be referred.

First, it is plain enough that the dog does not use words with any consciousness of their meaning to the hearer. His vocabulary is always given in order, beginning with "*Don*" and ending with "*Ruhe*." If the order of questioning is varied he is called "*Kuchen*" and he desires "*Hunger*," etc. (Here it may be noted that the author was unable to get even approximations to the last three words in the list accredited to the animal.)

Secondly, it is evident, says Mr. Pfungst, that he is not using words learned by imitation. The author assumes that any imitator of another speaker would vary the pitch, intensity or accent of his words as the imitator's were varied. Don's voice—a high tenor, ranging from F on the bass clef to the octave above middle c, usually pitched in talking near d above middle c—is not varied when the pitch of the questioner's voice is altered. Furthermore he does not imitate changes in accent or intensity. He is as likely to say "*Kúchen*" as "*Kúchen*"; "*Húnger*" as "*Húnger*," etc. From the legitimacy of the author's adoption of this criterion, however, the reviewer is inclined to dissent. His own experience with a child of two and one half years, learning readily to speak a large number of words and phrases from imitation, and able to give both vowel and consonant values with perfect distinctness, for several months was that she would not imitate changes of intensity or pitch, although she usually showed apparent willingness to try. To apply this principle in the case of the dog would require the assumption of an attentive ability as well as of motor skill, far in excess of any of which that animal has given evidence. But Mr. Pfungst offers other disproof of the imitation hypothesis which to the reviewer seems adequate. This is found in the method of learning. The first word which the dog is reported to have uttered is "*Haben*." We are assured that being asked, "Willst du etwas haben," he thereupon pronounced distinctly the words, "*Haben haben haben*," and was rewarded with food for his pains. When he afterwards at-

tempted to pronounce the words he would give many inarticulate gurgles, but the food was given only when the correct number of syllables were uttered at once. The owner's family state that ten repetitions, some a week apart, sufficed for this learning. The word, "*Ruhe*," was first uttered after a command, "*Ruhe*," by the owner's daughter. Hearing the dog's response, she demanded, "Was sagst du da," and obtained again the answer "*Ruhe*." He was then taught to give this word after his fifth question, "Was bittest du dir aus?" The name, "*Haberland*," which none of the investigators could obtain from him, was first answered without instruction to the question, "Wer hat den ersten Artikel über dich in die Zeitung gebracht?" These facts are hardly consistent with any provable experience in learning by imitation. Indeed, it may be remarked that to the reviewer, who has spent the greater part of two years in experimentation on the behavior of dogs under controlled conditions, the animals' vagueness of perception and extremely low degree of attention would make a very strong presumption against the possibility of their learning even the simplest acts by "observation and imitation."

Mr. Pfungst concludes that the speech of Don is therefore to be regarded properly as the production of vocal sounds which produce illusions in the hearer. He calls attention to the fact that not even the number of syllables in any given "word" of Don's is constant. The dog makes only one vowel sound, having a value lying between *o* and *u*, varying considerably, but usually nearer *u*. The experimenters could not hear from him certainly either *a* or *e*. His one guttural-aspirant is like the German *ch*, and does duty for *k* and *h*. There is also a nasal, of a value lying between *n* and *ng*. When it is not prolonged it passes for a *d*, as in "*Don*." He really never makes the sound of *b*, *d*, *k*, *l* or *r*. When he utters a word expressed by [(*ch*)*unguo*], not much effort is required from a suggestible hearer to perceive the sound as "*Hunger*." When in making phonograph records the questioner asked merely "Was?", the dog gave

the customary answers, "Don," "Hunger?" "Haben haben," "Kuchen," etc., of which however only two out of sixteen answers were intelligible. Of 168 answers preserved on phonograph records, 71 per cent. were disyllabic and of the monosyllabic noises 68 per cent. were given when a considerable pause had elapsed between the last answer and this question. The "answers" were really incorrect fully as often as otherwise. Disinterested hearers could seldom distinguish his "Hunger" from his "Haben," nor his "Ruhe" from his "Kuchen," etc. It was as easy for others to perceive some of these same sounds as "Engelhopf" or "Hallelujah"; "Huhn" or "Honig." Here it seems to the author we have a case quite parallel with our common interpretation of the night-swallow's call as "Whip-poor-Will" when in fact the sounds are nearly "Pfif-ah-rih"; and with the common German interpretation of their *Steinkanz's* "Kuwitt" or "Kuwiff" as "Komm mit," thus making him in popular superstition the messenger of death. But for a strong and uninhibited tendency thus to "apperceive" them, neither these calls nor the "words" of Don would be taken as other than meaningless noises.

On psychological grounds, Mr. Pfungst concludes, the explanation is comparatively simple; the uncritical do not make the effort to discriminate between what is actually given in perception and what is merely associated imagery, which otherwise gives to the perception a meaning wholly unwarranted; and they habitually ignore the important part which suggestion always plays in ordinary situations.

Accepting this explanation as satisfactory we may expect the majority of animal lovers to continue to read their own mental processes into the behavior of their pets. Nor need we be astonished if even scientists of a certain class continue at intervals to proclaim that they have completely demonstrated the presence in lower animals of "intelligent imitation" and of other extremely complicated mental processes—inferred from the results of brief and lamentably superficial

tests, and published as proven facts without further reflection.

HARRY MILES JOHNSON

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FOURTH LIST OF GENERIC NAMES FOR
THE "OFFICIAL LIST OF ZOOLOGICAL
NAMES," PROVIDED FOR BY THE
GRAZ CONGRESS

15.¹ The following generic names of Diptera are proposed for *inclusion* in the "Official List of Generic Names." The species mentioned are the correct types, according to Coquillett, 1910.

Anopheles Meig., 1818, 10, type *bifurcatus*.
Anthomyia Meig., 1803, 281, type *Musca pluvialis*.
Chrysops Meig., 1800, 23, type *cæciens*.
Corethra Meig., 1803, 260, type *Tipula culiciformis*.
Culex Linn., 1758a, 602, type *pipiens*.
Cuterebra Clark, 1815, 70 type *Æstrus cuniculi*.
Gasterophilus Leach, 1817, 2, type *Æstrus intestinalis* (cf. *Æ. equi*).
Hæmatobia St. Farg. & Serv., 1828, 499, type *Conops irritans*.
Hippelates Loew, 1863, 36, type *plebejus*.
Hippobosca Linn., 1758a, 607, type *equina*.
Hypoderma Latr., 1818, 272, type *Æstrus bovis*.
Lucilia Desv., 1830, 452, type *Musca cæsar*.
Musca Linn., 1758a, 589, type *domestica*.
Muscina Desv., 1830, 406, type *stabulans*.
Nycteribia Latr., 1796, 176, type *Pediculus vesper-tilionis*.

Æstrus Linn., 1758a, 584, type *ovis*.
Ophyra Desv., 1830, 516, type *Anthomyia leucostoma*.
Phora Latr., 1796, 169, type *Musca aterrima*.
Piophilæ Fall., 1810, 20, type *Musca casei*.
Psorophora Desv., 1827, 412, type *Culex ciliatus*.
Sarcophaga Meig., 1826, 14, type *Musca carnaria*.
Stegomyia Theob., 1901, 234, type *Culex calopus*.
Stomozys Geoffr., 1762, 538, type *Conops calcitrans*.
Tabanus Linn., 1758a, 601, type *bovinus*.
Tipula Linn., 1758a, 585, type *oleracea*.

16. The following generic names of Diptera are proposed for *exclusion* from the "Official List," on the ground that they are absolute homonyms and preoccupied.

Acanthina Wiedem., 1830, not Fisch., 1806.
Allocoptes Loew, 1872, not Mayr, 1864.
Ammobates Stann., 1831, not Latr., 1809.

¹ Paragraphs are numbered continuously with the earlier lists.

- Anepsius* Loew, 1857, not LeConte, 1852.
Anoplomerus Rond., 1856, not Latr., 1844.
Archilestes Schin., 1866, not Selys, 1862.
Ascia Meig., 1822, not Scop., 1777.
Aspilota Loew, 1873, not Först., 1862.
Asthenia Westw., 1842, not Hübn., 1816.
Astoma Lioy, 1864, not Oken, 1815.
Atomaria Bigot, 1854, not Steph., 1830.
Atrichia Loew, 1866, not Schrank, 1803.
Blacodes Loew, 1874, not Dej., 1859.
Blaz Loew, 1872, not Thom., 1860.
Brachygaster Meig., 1826, not Leach, 1817.
Calloplistria Loew, 1873, not Hübn., 1816.
Centor Loew, 1866, not Schönh., 1847.
Ceria Fabr., 1794, not Scop., 1763.
Chauna Loew, 1847, not Illig., 1811.
Chrysonotus Loew, 1855, not Swains., 1837.
Clytia Desv., 1830, not Lam., 1812.
Coprina Zettters., 1837, not Desv., 1830.
Coquillettia Willist., 1896, not Uhler, 1890.
Cyrtosoma Brauer & Bergenst., 1891, not Walk., 1829.
Dendrophila Lioy, 1864, not Swains., 1837.
Diabasis Macq., 1834, not Hoffmanns., 1819.
Diphysa Macq., 1838, not Blainv., 1834.
Discocephala Macq., 1838, not Lap., 1832.
Empheria Winn., 1863, not Hag., 1856.
Enicopus Walk., 1833, not Steph., 1830.
Erichsonia Desv., 1863, not Westw., 1849.
Eriogaster Macq., 1838, not Germ., 1811.
Eristicus Loew, 1848, not Wesm., 1844.
Eudora Desv., 1863, not Less., 1809.
Eumetopia Macq., 1847, not Westw., 1837.
Eumetopia Brauer & Bergenst., 1889, not Westw., 1837.
Euphoria Desv., 1863, not Burm., 1842.
Eurycephala Rond., 1881, not Lap., 1833.
Exocheila Rond., 1868, not Rond., 1857.
Fabricia Meig., 1838, not Blainv., 1828.
Fallenia Meig., 1838, not Meig., 1820.
Grassia Theob., 1902, not Fisch., 1885.
Halithea Hal., 1838, not Savig., 1817.
Helobia St. Farg., & Serv., 1828, not Steph., 1827.
Heteroneura Fall., 1823, not Fall., 1810.
Heterostoma Rond., 1856, not Hart., 1843.
Himantostoma Loew, 1863, not Ag., 1862.
Hydrochus Fall., 1823, not Germ., 1817.
Hyria Desv., 1863, not Lam., 1819.
Icaria Schin., 1868, not Sauss., 1853.
Idiotypa Loew, 1873, not Först., 1856.
Isoglossa Coq., 1895, not Casey, 1893.
Itamus Loew, 1849, not Schm.-Goeb., 1846.
Latreillia Desv., 1830, not Roux, 1827.
Laverania Theob., 1902, not Grassi & Fel., 1890.
Leptochilus Loew, 1872, not Sauss., 1852.
Leptopus Fall., 1823, not Latr., 1809.
Leptopus Hal., 1831, not Latr., 1809.
Lissa Meig., 1826, not Leach, 1815.
Lophonotus Macq., 1838, not Steph., 1829.
Macrochira Zettters.; 1838, not Meig., 1803.
Macrurus Lioy, 1864, not Bonap., 1841.
Meckelia Desv., 1830, not Leuck., 1828.
Microcera Zettters., 1838, not Meig., 1803.
Mochtherus Loew, 1849, not Schm.-Goeb., 1846.
Mycetina Rond., 1856, not Muls., 1846.
Myobia Desv., 1830, not Heyd., 1826.
Odontocera Macq., 1835, not Serv., 1833.
Okenia Zettters., 1838, not Leuck., 1826.
Omalocephala Macq., 1843, not Spin., 1839.
Pales Desv., 1830, not Meig., 1800.
Panoplitus Theob., 1900, not Gould, 1853.
Phoneus Macq., 1838, not Kaup, 1829.
Plagiocera Macq., 1842, not Klug, 1834.
Plagiotoma Loew, 1873, not Clap. & Lachm., 1858.
Plectropus Hal., 1831, not Kirby, 1826.
Polydonta Macq., 1850, not Fisch., 1807.
Psilopus Meig., 1824, not Poli, 1795.
Pygostolus Loew, 1866, not Hal., 1833.
Rhopalomyia Willist., 1895, not Rübsaam, 1892.
Ræselia Desv., 1830, not Hübn., 1816.
Rondania Jænn., 1867, not Desv., 1850.
Sargus Fabr., 1798, not Walb., 1792.
Sicus Latr., 1796, not Scop., 1763.
Stenomacra Loew, 1873, not Stal, 1870.
Stictoccephala Loew, 1873, not Stal, 1869.
Subula Meig., 1820, not Schum., 1817.
Tetrachæta Brauer & Bergenst., 1894, not Ehrenb., 1844.
Tetrachæta Stein, 1898, not Ehrenb., 1844.
Trichoptera Lioy, 1864, not Meig., 1803.
Triodonta Willist., 1885, not Bory, 1824.
Trupanea Macq., 1838, not Schrank, 1795.
Wulpia Brauer & Bergenst., 1893, not Bigot, 1886.

17. These names are published herewith for the information of all persons interested. They will be forwarded by July 1, 1912, to the International Commission on Zoological Nomenclature, the Commission on Nomenclature of the International Entomological Congress and to several entomological committees and societies.

18. A vote will be called on these names at the next meeting of the International Commission on Zoological Nomenclature, in the summer of 1913, and any objection to the proposed action should be filed with the under-

signed, and stating ground for the objection, not later than May 1, 1913.

C. W. STILES.

Secretary International Commission
on Zoological Nomenclature

SPECIAL ARTICLES

ENOTHERA NANELLA, HEALTHY AND DISEASED

IN my cultures of the evening primrose of Lamarck, the pure and self-fertilized seed yearly produces a certain percentage of mutants, among them dwarfs, *Enothera nanella*, the number of which usually amounts to about 1 per cent. of the whole crop. Of late, these dwarfs have been the subject of some discussion, since Zeylstra discovered the presence of a bacterium in their tissues and showed that some of their characters, formerly considered as specific marks, are, in reality, abnormalities caused by this parasite.¹ From this, some authors have erroneously concluded that the dwarfs are no real mutants, but only diseased individuals of the original type.²

Zeylstra, however, had pointed out that, under favorable conditions, the sideshoots of the dwarfs may become healthy and lose their abnormal characters; but their height remains the same as in the diseased stems. Hence we may assume that, under still more favorable conditions, the main stems themselves might grow up healthy, while still retaining the dwarfish stature.

About half a century ago, Liebig pointed out that nitrogenous manure is apt to increase the sensitiveness of plants to diseases, whilst phosphate of calcium is one of the best means to diminish this predisposition. Laurent found the same to be true for such diseases as are caused by those common bacteria of the soil, which, under normal conditions, are harmless, but may injure the cultures, whenever the manure is too rich in nitrogenous substances. He studied *Bacillus fluorescens putidus* and *B. coli communis*, both of which destroy the cellwalls by means of their enzymes,

¹H. H. Zeylstra, "Fzn. *Enothera nanella* de Vries, eine krankhafte Pflanzenart," *Biolog. Centralblatt*, 1911, Bd. XXXI., pp. 129-139.

²Sammelreferat by G. Tischler, *Zeitschr. f. ind. Abst.*, 1911, Bd. V., p. 327.

even before they themselves reach the cells. The bacterium of *Enothera nanella* is of a wholly different type, since it is found within the living cells and changes their growth without killing them. Zeylstra provisionally placed it in the group of *Micrococcus*.

From these data it is probable that healthy *O. nanella* might be obtained by giving them less nitrogen and more phosphate of calcium. Unfortunately, however, the nitrogen manure acts as the strongest stimulant, under our climate, to induce them to become annual, and for many reasons it is most desirable to have cultures of annual generations. It is, therefore, necessary to determine the amount of nitrogen and phosphate of calcium which will induce a sufficiently large percentage to become annual, but will not essentially heighten their liability to become diseased.

In the summer of 1911, I made some provisional experiments which show that, by this method, there may be produced almost wholly healthy specimens with the normal stature of the dwarfs. In the first place, I found that every part of the stem, every single leaf and flower, may be normal or diseased, in response to external influences. In the young rosettes of rootleaves the first leaves were formerly always twisted; then came long-stalked normal ones and, after these, the really abnormal leaves with broadened and shortened bases, which often killed the terminal bud before it could make a stem. By giving a large amount of phosphate of calcium, and as little nitrogen as possible, every one of the rootleaves could be grown healthy, with a stalk and a narrow wedge-shaped base. The same was the case with the leaves of the stem, and even with the flowers. The number of the abnormal ones could be brought down to a very few, thereby giving the whole plant the appearance of a healthy condition. All transitions between diseased and normal dwarfs were to be seen in these cultures.

Moreover, I have won beautiful healthy dwarfs by means of a cross from which the other parent was eliminated after the rule of the sesquicreprocal crosses.³ I pollinated a

³"Ueber doppeltreciproke Bastarde," *Biol. Centralbl.*, 1911, T. 31, pp. 97-104.

dwarf of *O. nanella* \times *biennis* with the pollen of an ordinary *O. nanella* and got a culture of *O. (nanella* \times *biennis*) \times *nanella* = *O. nanella* which contained a high percentage of healthy plants. They began flowering when only 20 cm. high, the first flower appearing at a height of 10 cm.; whilst *O. Lamarckiana* reached 1.50 m. before flowering, the first flower opening about 80 cm. above the soil. All their leaves were as narrowly elliptical and as clearly stalked as those of the *Lamarckiana* itself, whilst the flowers were free from those abnormalities which usually accompany the dwarfish stature.

Thus we see that the discovery of Zeylstra, far from diminishing the value of *Oenothera nanella* as a real and (in an experimental way) most useful mutant, has given the means of cultivating it in as healthy a condition as may be required.

HUGO DE VRIES

BEHAVIOR OF SPERMATOOA IN PLASMA

THE recent article of Loeb and Bancroft¹ and of De Meyer² in which their observations upon the behavior of spermatozoa in various sorts of solutions, such as extracts of eggs of the same species (De Meyer, eggs of *Echinus microtuberculatus*; Loeb and Bancroft, eggs of the common fowl), colloids, acids, alkalies, hypo- and hypertonic solutions, egg-albumen, blood serum and Ringer solutions are described open up a most interesting field for investigation. During the past summer while occupying a table at the Marine Biological Laboratory, Woods Hole (for the use of which I am indebted to Professor F. R. Lillie), I attempted to grow spermatozoa of *Arbacia punctulata*, *Mytilus edulis* and *Modiolus modiolus* in various solutions, some of which being listed above as used by these other workers.

¹ *Journ. Exp. Zoology*, 12: 381.

² *Arch. Biol.*, 1911, Bd. 26, H. 1, pp. 65-97:

"Observations et expériences relatives à l'action exercée par des extraits d'œufs et d'autres substances sur les spermatozoïdes." I have seen only Robert Lewin's review in the *Zentralb. für Biochemie und Biophysik*, XII, No. 19/20, of De Meyer's paper.

On August 2, I centrifuged *Limulus* blood plasma and made a hanging drop from the upper layer, which examination showed to be free from cells; into this drop I introduced a few sperms from *Arbacia*. Great difficulty was experienced in attacks of bacteria and many of the preparations were discontinued the following morning. The slides were sealed with vaseline, as in the usual culture mount, and left at room temperature. By the eighth of August there was no movement in the sperms, although it had persisted up until that time and therefore the copper component of the blood of this animal does not seem to be toxic for *Arbacia* sperms, but none of the phenomena about to be described from mounts in different media were observed.

On August 5, a culture was made in the sterile agar medium, made according to the customary bacteriological formula, diluted so that it was liquid but highly viscid at 20° C. The spermatozoa lived only a short time and were seen to disintegrate within 24 hours. It may be stated that the reaction of the agar was estimated only roughly by an indicator and not titrated, so that I am not certain whether the medium was suitable from this standpoint. Care was taken to render the sea-urchins as free from bacteria as possible, the tests being washed off with HgCl₂, 1:1,000 before the cuts were made and sterile sea-water was used to receive the testes after extirpation. The mounts remained sterile throughout the time of observation, showing that the testes are bacteria-free, as one would suspect.

The plasma of a Norway rat was then tried on August 8 and this was prepared by centrifuging the blood of the rat in paraffin-lined tubes at about 8°-10° C. The plasma clotted when the hanging drop was made at room temperature, but sufficient time elapsed before the plasma clotted for the introduction of the sperm. The behavior of the sperm-heads was discovered to be quite like that described by Loeb and Bancroft for the sperm of the fowl, for the heads enlarged, became less dense, and distinct chromatin granules were visible, even in unstained preparations, resembling the nuclei of the spermatids of certain insects

which I have observed in a living condition without stains, the appearance being in this case checked with stained preparations. The sperms were active and the head and tail wriggled in their characteristic manner as long as they were visible. The tail became shorter and shorter as the head swelled, but in none of my specimens did the tail-cytoplasm completely incorporate itself into the head. This is true, I believe, for Loeb and Bancroft's experiments. In other words, a completely rounded out cell, like a spermatocyte, did not appear in these preparations.

De Meyer succeeded in causing the heads to swell by growing the sperms in a dilute solution of gelatin (*gelatin sol*); every indication pointed to the perfect imitation of the formation of the pronuclear condition in a normally fertilized egg. It is of the greatest interest, too, to observe that the experiments made by De Meyer in acid solutions gave exactly the same result as colloidal solutions in general—that is, a swelling in acid media.

These experiments and those of Loeb and Bancroft show the possibility of approaching the explanation of the behavior of the spermatozoon during fertilization upon physical-chemical grounds. Factors leading to mitosis should be determined and the various artificial parthenogenetic reagents should be tried.

I have recently determined, also, that if a trace of saponin be added to the water in which the spermatozoa of *Cerebratulus* lie, there is a slight cytolysis and swelling of the head of the spermatozoon, but the "tail" is not affected, apparently. Whether mitosis can be induced in this manner, as it can in the egg, in the formation of polar bodies, as I have elsewhere described, remains yet to be determined.³

MAX MORSE

TRINITY COLLEGE,
HARTFORD, CONN.,
April 10, 1912

³I am under obligation to the officers of the biological laboratories of Yale University, Professors Harrison, Coe, Woodruff and Petrunkevitch, for the opportunity to study living nemertean eggs and sperms.

SOCIETIES AND ACADEMIES

RESEARCH WORKERS IN EXPERIMENTAL BIOLOGY, WASHINGTON, D. C.

At the meeting of this society, held on February 21, 1912, Dr. William N. Berg, of the Bureau of Animal Industry, gave a critical exposition of Zuntz's theory in regard to the physical-chemical basis of striated muscle contraction,¹ in which it was pointed out that this theory had many objectionable features. These may be summarized briefly as follows:

(a) Lymph contains practically no carbon dioxide in the gaseous state.

(b) Gases dissolved in water do not behave entirely like true solutes, and exert no osmotic pressure; exceptions are hydrochloric acid, ammonia and a few other gases.

Accordingly, the carbon dioxide produced by muscle contraction can not exert any osmotic pressure, and, furthermore, it is not shown in Zuntz's work that the walls of the muscle rods are impermeable to carbon dioxide during the contraction phase. This is necessary, for otherwise osmotic equilibrium could not be brought about by the inflow of water alone; an outflow of carbon dioxide must take place. A further objection is that carbon dioxide at the moment of its formation does not have a temperature of nearly 6000° C.

At the March meeting, held on the 20th inst., Dr. William Salant, chief of the pharmacological laboratory of the Bureau of Chemistry, gave a brief résumé of the caffeine investigations which were conducted in the Department of Agriculture, and which embrace studies on the effects of different amounts of caffeine upon the organism, with especial reference to the production of acute and chronic intoxication. Other factors, such as the influence of diet, age, season, etc., were considered.

In conjunction with the tests, which were done with carnivorous and herbivorous animals, the rate of demethylation of caffeine and the elimination of caffeine in the urine and gastro-intestinal canal were noted under normal and pathological conditions.

In addition to the above, the results of experiments upon the effect of caffeine upon the circulation, with particular regard to synergism and the antagonism of other drugs, were reported.

LEWIS W. FETZER

¹"Die Kraftleistung des Tierkörpers; eine Festrede," Kgl. Landw. Hochschule Berlin, 1908.

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

THE eleventh regular meeting of the society was held at Mr. Crawley's residence on April 16, 1912, Mr. Crawley acting as host and Dr. Graybill as chairman.

In connection with Dr. Ransom's notes on cysticerci, Dr. Cobb called attention to a remarkable case of hydatid disease in Australia, where a man who had had a considerable part of the liver removed, owing to a hydatid infestation, subsequently returned for operative removal of another hydatid. It was found on operation that the second parasite was in another part of the liver and that there had been a practically complete regeneration of the excised portion of the liver.

The evening was devoted to the exhibition and discussion of apparatus, drawings and specimens by Dr. Cobb.

A set of screens for collecting free-living nematodes was shown, the screens being oblong instead of circular, and therefore easier to pack in a suitcase in field work. Two screens using a detachable silk bolting-cloth, instead of an attached brass-wire screening, have a new fastening device consisting of a string looping around projections from the tins. A wooden container for holding collecting bottles fits inside of the screens and of some collecting trays of the same shape as the screens.

Dr. Cobb remarked that he had secured superior results by using sea water in his sublimate fixing reagents, nematodes staining very much better after such treatment. He suggested that this might be due to traces of various chemicals in the sea water, rather than to an increased solubility of the sublimate used.

In connection with a number of specimens and drawings of nematodes, Dr. Cobb pointed out that there is a possibility that some of the free-living forms will be found to show traces of internal segmentation in the arrangement of the internal organs and their relation to the external markings. In an undescribed genus he noted the association of a strong buccal spear with a weak pharyngeal suction bulb, and surmised that the retrorse annulation in this form served to hold it in a tangle of vegetation so that the buccal spear could be used effectively in the absence of a strong suction bulb to fix the mouth in using the spear. In this genus the buccal spear is lost by the male in an ecdysis.

Dr. Cobb expressed the opinion that the study of nematodes will have to be separated from para-

sitology or helminthology as covering a field of size and importance equal to that of such subjects as entomology. The nematodes make up an isolated group with a very wide range of morphological structure, life history, habits and geographical distribution. The group includes parasites of vertebrates and invertebrates, parasites of plants on land and in water, free-living forms that eat vegetable matter, some that feed exclusively on diatoms, some that feed on bacteria and some that eat other nematodes. Broadly speaking, the mouth parts show the same general lines of variation that insects show, some being adapted to biting, others to sucking or stinging, and it is possible that the buccal stylet of *Mononchus* serves as a poison fang to benumb the nematodes on which this genus feeds. The life histories and methods of reproduction are very variable and include parthenogenesis. Nematodes occur in the soil and in the ocean in immense numbers and have been found in the polar regions. There are probably as many species as there are of insects, and some of the well-marked genera will probably be found to have as many as 500 species.

Some of the nematodes, such as *Streptogaster*, have an anterior dilatation of the intestine which appears to be morphologically and physiologically a stomach.

Dr. Cobb gave an interesting demonstration of the method of obtaining the decimal nematode formula, showing that it could be obtained with no great effort in about six minutes.

MAURICE C. HALL,
Secretary

AMERICAN PHILOSOPHICAL SOCIETY

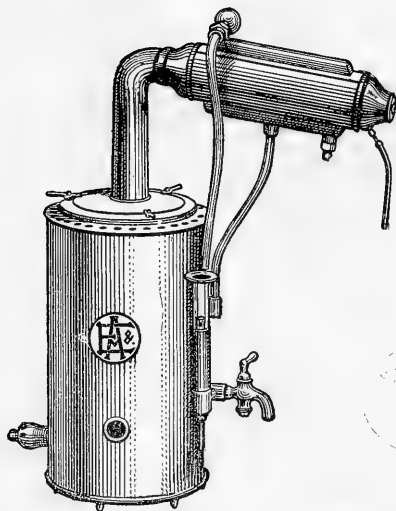
ON April 12th, Dr. Willis F. Manges, Röntgenologist to the Jefferson Medical College Hospital of Philadelphia, read a paper before the American Philosophical Society on the X-rays. He reviewed briefly the history of the discovery and especially noted the great progress in safety and efficiency of the apparatus and methods of to-day as contrasted with the earlier results. By means of the modern methods of protection, X-ray injury is now almost entirely eliminated. He discussed the value of the X-rays in medicine and surgery both in diagnosis and treatment. He pointed out also that interpretation of the Röntgenographs required special skill, which could only be gained by a wide experience or careful training and that there was danger in their indiscriminate use in medico-legal cases because of the difficulties of such interpretation.

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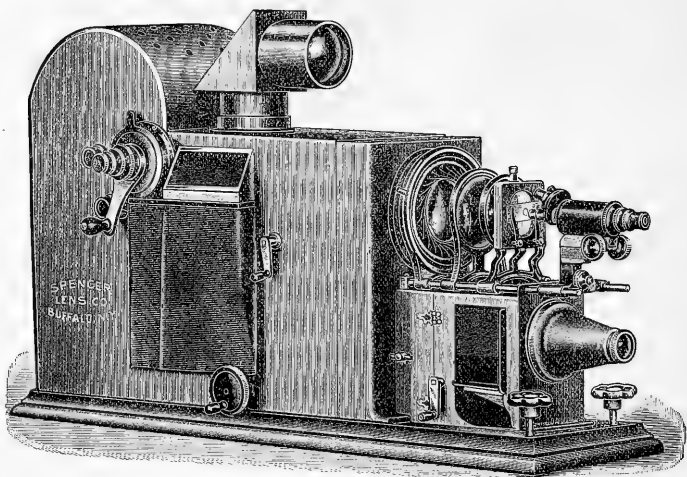
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THE problem of heredity has been attacked in four principal ways. Galton developed to a high degree what we may call the statistical method. His most important conclusions are embodied in his law of ancestral inheritance and his law of regression. According to the former, the two parents together contribute one half of the total inheritance of an individual, the four grandparents one fourth, the eight great-grandparents one eighth, and so on indefinitely. The law of regression attempts to state the average deviation of a fraternity from the mean of the general population in terms of the average deviation of the two parents. Recent investigations have shown that neither of these laws is true except for averages of large numbers of cases, and not in all cases even then. They are not applicable to individual cases, and are hence of no importance in the modern science of genetics, however important they may be in statistical problems in general.

In recent years the methods used by Galton have been developed by Pearson and others into a highly mathematical treatment of the subject of heredity, which has given us important means of dealing with the precision and reliability of data and enabled us to study certain types of correlation to advantage, but which has otherwise had comparatively little influence on the progress of genetics. The study of correlation between hereditary characters by statistical methods has not as yet led to

¹Presidential address before the Washington Botanical Society, March 5, 1912.

discoveries of any great usefulness in the work of producing new and improved races of plants and animals, however useful it may have proved in other directions, or may yet be in genetics.

Another method of study has been that of the cytologist. A long list of able investigators have in recent years given attention to the phenomena of cell division, especially the process by which gametes, or reproductive cells, are produced. Very soon after the rediscovery of Mendel's principles cytologists pointed out that the behavior of the chromosomes in the reduction division is sufficient to account for Mendelian phenomena if a proper connection between the chromosomes and Mendelian characters could be proved. One of the most important results achieved in this line of investigation is the demonstration of a relation between certain chromosomes and the determination of sex. The work of Professor E. B. Wilson has been especially convincing in this respect, though many other investigators, especially Professor Morgan and Miss Stevens in this country, and Boveri, Baltzer and others in Europe, have contributed important results. The net results of these investigations are that in most species the female possesses a pair of chromosomes of peculiar character, usually distinguishable from the other chromosomes, and, because of their behavior in the prophase of the first maturation division, called by many cytologists "idiochromosomes." The male has only one of this type of chromosome. From the behavior of these idiochromosomes it results that all the eggs contain one idiochromosome, while the sperm is of two kinds, one containing a single idiochromosome, the other none. Eggs fertilized by the former produce females; by the latter, males. In a few species the female has only one of these peculiar chromosomes,

while the male has none. In these species the female produces two kinds of eggs, one female-producing, the other male-producing; while the male produces only one kind of sperm. These investigations have thus given strong reasons for believing that sex is an inherited character, and is hence not determined by external conditions.

These facts have been demonstrated for a large number of species (over a hundred), including man.

While in most species the male possesses but one of these presumably sex-determining chromosomes, it frequently happens that this chromosome has a synapctic mate, which, however, appears not to be concerned in sex production. This synapctic mate consists in some cases of a single chromosome; in others it consists of a group of chromosomes varying in number from 2 to 5 in different species; in still others it is wanting entirely. These facts are of special interest in connection with the further fact that a large number of ordinary somatic characters have been found to form Mendelian pairs with the sex element. Thus, in barred Plymouth Rock poultry the barring of the feathers is transmitted by the female only to her male offspring. Many human affections are transmitted in a similar manner, such as night blindness, color blindness, etc. Pearl has shown that high egg-laying quality in poultry is similarly sex-limited. Females do not transmit this quality to their daughters, but do transmit to their sons the power of transmitting to the granddaughters high egg-laying quality. A long list of such sex-limited characters has been demonstrated. These facts raise the presumption that these sex-limited characters are related to the chromosomes—in what manner of course we do not know.

On the history of the chromosomes during the life history of the cell, especially—

during the events immediately preceding the metaphase of the reduction division, cytologists are somewhat divided on matters of fact. They are in essential agreement so far as the genetic continuity of the chromosomes is concerned, *i. e.*, they believe that each chromosome is directly descended from a previous one. There are cases, however, where the propagation of the chromosomes is not a simple matter of division in which all the substance of the old body passes directly into the two new ones formed from it by division.

The manner of formation of bivalent chromosomes in the early stages of the reduction division is still a matter of dispute, as is also the possibility or probability of exchange of substance between synapctic mates. A review of the work on this subject would be highly interesting, but would extend this paper beyond all reasonable limits.

Recent work has shown that many chromosomes are really compound bodies, and that what we have regarded as independent chromosomes are, in some cases at least, really groups of chromosomes. This fact may have an important bearing on partial or even complete correlation between hereditary characters, as well as the fact that in some species more Mendelian pairs have been demonstrated than there are pairs of chromosomes.

A third type of investigations relating to heredity is the study of the chemical processes concerned in development. A great deal of the work of the physiological chemist has a bearing on this subject, though not instituted directly for this purpose. This study has led to the conclusion, as Guyer states, that at least a principal function of the chromatin is the production of enzymes which, by their regulating effects on metabolic processes, produce important effects in the development of the

organism. Recently Gortner, of the Carnegie Institution, and Miss Wheldale, of Cambridge University, have attempted to work out the chemistry of certain of the pigments, with important results. For instance, Gortner has shown that, in the potato beetle, oxidizing enzymes are generally present in the body, while chromogen, which these enzymes convert into pigment, is produced locally in the integument in small quantity, and only in those locations where the characteristic pigment spots occur. One of our own members, Dr. Bartlett, is now doing some interesting work on the chemistry of anthocyan, and has become greatly interested in this phase of heredity investigations. Such investigations relate, of course, to the manner in which the hereditary characters make their appearance in development, not to the transmission of these characters.

This phase of heredity investigations is, as yet, only in its infancy. It is, however, one of the most important at the present time, for we can not go a great deal further in the interpretation of the phenomena of heredity until we know more of the chemical processes involved in the development of a complex organism from the fertilized egg.

Lastly, we come to the study, by experimental cross-breeding, of the behavior in inheritance of the various characters which distinguish nearly related organisms from each other. If relative importance were to be judged solely by the amount of data accumulated, this would be by far the most important phase of the subject before us. Here we have a plethora of fact and a dearth of meaning. We have now reached a point in the study of Mendelian inheritance where satisfactory interpretation of fact is quite as important as the collection of more facts. We need stimulating theories that will point out new directions for

research. When Mendel's laws were rediscovered practically simultaneously in the closing year of the last century, by de Vries, Correns, and von Tschermak, biology received such a stimulus as it has not felt since the publication of the "Origin of Species" in 1859. But what was it that gave this stimulus? Was it the collection of facts? Was it the wonderful collection of facts regarding variation made by Darwin that electrified the scientific world in 1859? Or was it a satisfactory interpretation of these facts? Darwin gave his facts *meaning*. Similarly, it was an *illuminating interpretation* of facts that made an epoch in the development of biological science when Mendel's principles were rediscovered. The fact that this discovery lay unnoticed for a third of a century and then suddenly became the leading interest of biologists is a remarkable commentary on the relation of science to human welfare in the last century and in the present.

The leading principle discovered by Mendel was that a hybrid whose parents differ in respect to a single factor of development, produces two kinds of gametes, respectively like the gametes of the two parents. This is now known as the law of segregation. In the early years of the present century genetic investigations dealt mainly with the universality of this law. This question is now practically settled, so far as can be by experimental cross-breeding. We now have a vast amount of data which need further interpretation that will point the way to new *kinds* of facts. The mass of data which has accumulated during the past dozen years has been variously interpreted by different investigators. It has furnished an extensive vocabulary of new terms, to which various meanings have been attached. Some recognized authority has suggested a new view concerning the nature of the so-called "unit-characters,"

and this view has been widely accepted with no critical examination of its intrinsic merits. The weight of authority here, as elsewhere, has been an incubus on the progress of scientific interpretation.

Mendel himself did not make use of the term "unit-character," but refers the phenomena he observed to *differences between formative elements* in the cells of hybrids. This is made clear in the following quotation from his original paper:

With regard to those hybrids whose progeny is variable we may perhaps assume that between the differentiating elements of the egg and pollen cells there occurs a compromise, in so far that the formation of a cell as foundation of the hybrid becomes possible; but nevertheless the arrangement between the conflicting elements is only temporary and does not endure throughout the life of the hybrid plant. Since in the habit of the plant no changes are perceptible during the whole period of vegetation, we must further assume that it is only possible for the differentiating elements to liberate themselves from the enforced union when the fertilizing cells are developed. In the formation of these cells all existing elements participate in an entirely free and equal arrangement, in which it is only the differentiating ones which mutually separate themselves. In this way the production would be rendered possible of as many sorts of eggs and pollen cells as there are combinations possible of the formative elements. . . . The differentiating characters of two plants can finally, however, only depend upon differences in the composition and grouping of the elements which exist in the fundamental cells of the same in vital interaction.

Thus instead of "unit character" Mendel speaks of "differentiating characters," and instead of pangenesis in the germ plasm he speaks of "formative elements," differences in which are responsible for the differences in related organisms. Nowhere does he advance the idea that the germ plasm is composed of independent elements, each of which is responsible for the development of a definite portion of the organism. The latter idea is due to de

Vries. Until within the last two or three years the de Vriesian interpretation of Mendelian phenomena has been widely accepted, especially in England and in Germany. Generally speaking, American biologists have hesitated to accept the de Vriesian doctrine, preferring to regard the developed organism not as a structure composed of definite elements independent of each other in hereditary transmission, but rather as a complex resultant of the interaction of various cell elements no one of which is wholly responsible for any definite part of the organism.

In consonance with the de Vriesian conception, the idea early developed that the organism is a collection of "unit characters" arranged in pairs, any one of which might be replaced by certain others. Bateson, in 1901, in presenting to the Royal Horticultural Society a translation of Mendel's original paper, uses the following words:

In so far as Mendel's law applies, therefore, the conclusion is forced upon us that a living organism is a complex of characters, of which some, at least, are dissociable and are capable of being replaced by others. We reach thus the conception of unit-characters, which may be rearranged in the formation of the reproductive cells.

This is the first use of the term unit-character the writer has been able to find. The idea that hereditary characters are indivisible units is, however, due to de Vries. In de Vries's original paper on the law of segregation he remarks:² "According to the principles which I have elsewhere announced (Intracellular Pangenesis), the specific characters of organisms are composed of units quite distinct"; and, again, "for the simple character must be considered as an individual unit." The term "unit-character" did not come into

²I am indebted to Dr. Geo. H. Shull for the following citations relating to the history of the unit-character conception.

general use until about 1905 or 1906. The fact that it presented a conception easily apprehended, and the further fact that this conception lends itself readily to a convenient system of symbols for representing the phenomena concerned, led to the rapid adoption of the new phraseology even by those who reserved their opinion as to the philosophy on which the idea was based.

We have already seen that Mendel himself referred the phenomena he observed to differences in formative elements in the germ plasm, which were "in vital interaction." The de Vriesian philosophy, on the other hand, did not place much stress on this vital interaction, but looked upon each hereditary character of the organism as the expression of a particular element in the germ plasm which was, more or less independently of all others, responsible for the development of that character. A pair of segregating characters, such as smoothness and wrinkling in pea seeds, was looked upon as due to a corresponding pair of pangenes in the germ plasm, one of which, if allowed free action, would produce smoothness, the other wrinkling. Bateson's term *allelomorph* was generally used to refer to these hypothetical organs in the germ plasm, rather than de Vries's original term *pangene*, since the former term could be applied to the visible characters themselves as well. Later, when certain non-contrasting characters were found to segregate from each other, Bateson gave this phenomenon the name "spurious *allelomorphism*." An example already given of such a pair of segregating characters which are not contrasted characters is femaleness and the barring of the feathers in Plymouth Rock fowls; this means that when the reduction division occurs one of the resulting cells carries the potentiality of femaleness, the other that of producing bars on the feathers. Many other instances

of such pairing of unrelated characters are known in both plants and animals.

About 1903 a new conception of the pair of allelomorphs arose. In that year, both Correns and Quenot foreshadowed what was more definitely suggested by Bateson and Punnett in 1905, as the "*presence and absence hypothesis*." C. C. Hurst the next year developed this hypothesis to its logical conclusion.³

According to this hypothesis the difference, say, between two varieties of cowpeas, one of which has red and the other white seed coats, is due to the presence of an allelomorph for red in the one case and its absence in the other. When the reducing division occurs in the hybrid this allelomorph was supposed to pass entire into one of the daughter cells, thus giving two types of gametes, one with, the other without, the potentiality of producing red pigment in the seed coat. It is usually assumed that the dominant member of the character pair corresponds to the presence, and the recessive member to the absence, of an allelomorph, though there are apparent exceptions to this rule.

While some biologists still adhere to the idea that the organism may be regarded as a structure built up of parts each of which represents a separately inherited character and is represented in the germ plasm by a pangene, this idea is much less prevalent than it was a few years ago. Recently the attempt has been made to formulate a description of Mendelian phenomena in terms that do not involve any hypothesis concerning the nature and interaction of the germ plasm elements which are certainly responsible for these phenomena. Notable amongst such attempts is the "genotype-conception" of Johannsen.

³ I am also indebted to Dr. Shull for these historical facts concerning the presence and absence hypothesis.

Johannsen does not define very definitely his term "gene," further than to apply it to the cell organs or cell substances, whatever they may be, that are responsible for Mendelian phenomena. He particularly insists that the gene is not to be regarded as the basis in the germ-plasm of a particular character, but that Mendelian phenomena arise from differences in corresponding genes in two varieties. This idea is in close accord with that of Mendel, which we have already discussed. Johannsen's gene and Mendel's formative element appear to be the same thing. Any particular character is probably the result of the interaction of several or many genes, and any one gene may bear a relation to many characters.

In a field of investigation where so much confusion has existed as to the meaning of terms, and where widely different views have been maintained as to the significance of the phenomena observed, it is necessary, in order to render discussion fully intelligible, to describe quite accurately the facts, which are not in dispute, and thus attach definite meanings to the terms used. It is not so important that we should agree as to the proper use of terms as that we should understand clearly the actual meaning of a writer, whether he uses terms correctly or not. In order that the meaning which I attach to the term "Mendelian factor" may be made clear, I shall set forth in some detail the facts about a group of these factors with which I have been working for some years past.

In my investigations of heredity in the cowpea (*Vigna unguiculata*) the seed-coat colors found are as follows: white (or cream), red, buff, blue, brown, black and purple. In addition to the simple colors above enumerated, certain varieties have the surface more or less thickly covered with bluish purple dots (speckling). In

the New Era variety these dots are very numerous, while in the variety known as Taylor the dots are more thinly scattered, with considerable areas free from them. Certain other varieties, notably the whip-poorwill, are characterized by a peculiar mottling of the surface in which irregular areas of darker shade are separated by lighter areas, apparently of the same coloring material, but less dense. There are also two genetically distinct types of "eye," the data concerning the inheritance of which have already been published.⁴ Finally, certain varieties are characterized by irregular longitudinal stripes on the sides of the seeds. We have thus, in all, 13 pairs of Mendelian characters relating to the seed coat.

Except the purple color, the inheritance of all the above characters has been worked out quite completely. Purple was introduced into my crosses from a variety that had only a small color patch about the hilum, and was not recognized as a distinct color type until after the crosses had been made. It happened that the crosses made were not such as to bring out in full the relations of this purple color to the other Mendelian factors involved. Its inheritance will be investigated later.

Without postulating anything whatever as to the nature of the Mendelian factors involved in the development of these colors, I will first set forth some of the more important facts that have been worked out concerning which factors must be present in order that a given color may develop. Since we do not know what these factors are, and hence can not give them names based on their nature, and since we do know their behavior in inheritance and the relation of their presence and absence to the development of the colors, I shall give

them provisional names based on their behavior and their relations to color development, and then, for convenience, reduce these names to mere symbols.

In no case is there a single Mendelian factor that can by itself give rise to colored seeds. I have been able to demonstrate that red, buff and brown seeds each require at least two factors. They may require others, but if so these others have not been detected. Black requires three factors and blue three.

If all these factors were distinct, these five colors would thus require twelve separate factors for their development; but the whole number of these factors for color (omitting purple) is only six. The same factor takes part in the development of more than one color. In fact, there is one that is common to the whole series, and when this factor is absent white seeds result, even if the remaining five are all present. We may designate this factor as the general color factor, and represent it by the symbol *C*. If we represent the other five factors by the letters *R* (red), *U* (buff), *Br* (brown), *B* (blue) and *N* (noir = black), the conditions required for the production of each color in this series, as shown in the breeding experiments, is shown in the following table:

CONDITIONS REQUIRED FOR DEVELOPMENT OF COLORS

Colors	Factors Necessary	Factors Having no Effect	Factors Which Must be Absent
White		<i>R, U, Br, B, N</i>	<i>C</i>
Red	<i>C, R</i>	<i>N</i> or <i>B</i>	<i>U, Br, B</i> or <i>N</i>
Buff	<i>C, U</i>	<i>R, N</i> or <i>B</i>	<i>Br, B</i> or <i>N</i>
Brown	<i>C, Br</i>	<i>R, U, B</i>	<i>N</i>
Black	<i>C, Br, N</i>	<i>R, U, B</i>	
Blue	<i>C, N, B</i>	<i>R^s, U^s</i>	<i>Br</i>

In this table the names of the colors are given in the first column. In the second column are given the factors that must be

^s These do not affect blue, but are visible with blue.

⁴ *Amer. Nat.*, Vol. XLV., No. 537, September, 1911, pp. 513-24.

present in order that a given color shall appear. Thus none of these six factors is necessary to the production of white seeds. For red seeds there must be present the factors *C* and *R*; and so on. It will be noticed that the factor *C* is necessary in all the colored types.

The third column shows the factors whose presence or absence is immaterial in each color type. Thus white seeds may or may not possess any or all the factors except *C*. Judging from results secured by others in other species, there could also be white seeds possessing the factor *C*, provided all the other factors concerned in color production were absent, but thus far I have not found white seeds of this character in cowpeas.

In the case of red and buff seeded varieties it will be noticed that *N* or *B* may be present, but they may not both be present. The reason for this is that *C*, *N*, and *B* are the factors for blue; hence if both *N* and *B* were present in red or buff varieties these would be converted into blue. Opposite blue, in the third column, *R* and *U* are given as factors that may be present without modifying the blue color; while this is true, it is also true that these colors (red and buff) can be seen along with the blue in blue seeds. This seems to be due to the fact that blue is a sap color, and is usually not very intense, while red and buff are pigments in granular form. It is interesting to note at this point that these surmises of mine as to the nature of these colors have been confirmed by Dr. Mann, to whose work with these pigments I shall refer later.

The last column shows factors that must be absent in the various color types. Thus, if *C* is present, white seeds do not occur, unless indeed all the other factors are absent as well. The factor *U* can not be present in red seeds, for it would convert

them into buff. In general, omitting blue, each of the colors named in column one completely conceals, or possibly prevents the development of, all those above it. Hence the factor *Br* can not be present in red and buff seeds. As already stated, the factors *B* and *N* can not both be present in red seeds, and the same is true of buff, though either of them may be present if the other is absent. The factor *N* must be absent in brown seeds, for otherwise we should have all the factors for black, and black renders brown invisible. Similarly, the factor *Br* may not be present in blue seeds, since it would change their color to black.

All the factors mentioned in this table are fully demonstrated in the experimental work, the full data of which will be published later. Not only that, but these factors, whatever they are, can be shuffled about and combined in any manner desired, practically at will. There are no intermediate stages to be dealt with. A factor is either present or not present, and that is the end of it. The only difficulty that presents itself in attempting to produce any color desired lies in the indifferent factors shown in the third column of the table. In some cases it is necessary to test a variety by appropriate cross-breeding in order to ascertain what characters are concealed in it, before we know what to expect when it is crossed with certain others. This will be necessary, for instance, in order to ascertain whether a brown variety possessed the factors *R* and *U*. It would not be necessary, however, to test any variety having colored seeds in order to learn whether it contains the factor *N*, for if *N* is present the green parts of the plant will exhibit anthocyan, which they will not do if *N* is absent. To learn whether a white variety contains *N* we should cross it with brown, in which case

the hybrid would be black or brown according as the factor *N* is or is not present.

This factor, to which I have given the symbol *N*, and which is necessary to the production of both blue and black seed-coat colors, is, as already stated, one of the factors for the production of anthocyan in the green tissues, and this was one of the reasons which led me to suspect that the blue pigment is a sap color. This same factor *N* is also one of those necessary for color in the flowers. But its importance in the economy of the plant does not seem to stop here. It may be merely a coincidence, but amongst about 4,500 third-generation plants grown in my experimental plots last year, this factor was present in every one of them that made even a fair yield of seed, except one strain of browns, and, with this exception, in those plants which lacked this factor the yield of seed was very meager. Furthermore, it is present in every standard variety of cowpeas in this country, so far as I have observed, although many varieties have doubtless been produced that did not possess it. These facts would seem to indicate that this factor is in some way connected with vigor and vitality in the plant.

Regarding the above colors, my breeding experiments led me to think that red, buff, brown and black were pigments related to melanin, and that blue was a sap color related to anthocyan. Dr. Albert Mann has made a study of this matter and has secured interesting and important results, which he will publish later. He kindly permits me to state that these surmises of mine were correct. I mention this fact to show that breeding experiments may be helpful to the chemist in investigating the chemical nature of these pigments.

We now have before us some of the facts that so badly need interpretation. The case is not nearly so simple as this state-

ment of facts would indicate, for there are other important classes of facts that I have not considered because to do so adequately would require too much space. It is not surprising that such facts as these have led to much controversy. It is inevitable that the human mind shall attempt to comprehend what it clearly apprehends, and hence that theories of various kinds should have been proposed to explain these facts. When we consider the fact that these factors can be shuffled and recombined in every possible way, just as if they were concrete entities, each represented by an independent morphological element in the germ plasm, it was to be expected that theories should be proposed involving such elements. It is inevitable that this should have been the case. Such theories present a simple idea, easily grasped, leading to an almost absurdly simple scheme of symbols for portraying the facts of segregation and recombination.

Some of these theories have gone so far beyond the present possibilities of investigation that many biologists, especially those only slightly familiar with the facts of Mendelism, have entered vigorous protests, and have even gone so far as to try to rule the facts themselves out of court. I wish to suggest to those who have not themselves conducted Mendelian studies, that it is well not to be too dogmatic about the facts in a field of investigation with which one is not very familiar. It would be a serious matter to convince any one who has watched the shifting and recombining of these factors that they are not real things. For one not thoroughly familiar with Mendelian phenomena to question the *facts* of segregation and recombination is as unseemly and unscientific a procedure as it would be for me to question the facts of physiological chemistry. The real trouble is not with the facts. It is with the interpreta-

tion of these facts. Just at present we have more facts of a certain kind than we know what to do with. We need some one to put meaning into these facts. We are in the position of a man lost in a wilderness. What he needs to find is a road. It does not make so much difference where this road shall lead, for all roads lead into each other. If he can find any road, it will lead him to where he can find people, and these can point out other roads leading more nearly in the direction he wants to go.

In genetic investigations we need theories that will suggest lines of investigation that will be fruitful of results—that will lead, not to more facts of the kind we already have, but to new kinds of facts that will throw light on the subject from a new angle. “Theories,” said Pasteur, “come into our laboratory by the bushel. When they have served their purpose, they are thrown out of the window.” This has been so in the development of the science of genetics, but just at present the supply of theories is almost exhausted.

The things that need interpretation are the manner in which segregation and recombination are brought about, the nature of the things that segregate and recombine, and their relation to the processes of development. Mendelian factors, that is, those factors of development that behave in Mendelian fashion in heredity, of necessity relate only to those differences that exist between organisms that are closely enough related to cross-breed with the production of fertile progeny. In certain species crosses, and in some other cases in which there is reason to suspect either a diseased condition of the cytoplasm, or a departure from the normal behavior in gametogenesis, cases have been found in which the factors of development do not segregate and recombine in the simple manner represented by the Mendelian formulæ. Aside from

these cases, it seems a fair inference from the results thus far obtained that the differences between organisms sufficiently related to permit of cross-breeding with the production of fertile offspring which reproduce sexually in a normal manner, are universally subject to the laws of segregation and recombination. There is one quasi-exception to this statement; there are certain factors that, instead of segregating in the usual presence-absence fashion, segregate from each other, so that they can not reside permanently in the same pure-breeding line. In my cowpea investigations I have found a set of three such factors; when only one of these is concerned in a cross we get the usual phenomena of presence-absence segregation. But if any two of the three are brought together in the same zygote they segregate from each other. These three factors are the factor *Br*, above mentioned (the special factor for brown pigment in the seed coat), and the New Era and Taylor types of speckling.

The question whether the deeper and more fundamental characters of the organism, such as are concerned in the differences between organisms widely separated in the organic world, are inherited in Mendelian fashion is purely academic and of no practical importance either to the theory of heredity or the practise of the breeder, for this question can never be submitted to experiment, nor could the most definite knowledge on this point be applied in the production of new and improved races of plants and animals.

At present Mendelists are plodding along practically without working theories. Let us hope that some of them will stumble on to facts of a new kind that will give meaning to those we already have.

Personally, I am of opinion that the chemistry of the pigments is a field that is of great importance to the theory of

heredity. The facts regarding the inheritance of color are better known than is the case with other groups of characters. The suggestion that the "factors" above mentioned are merely the power of producing certain chemical substances seems to me to be worthy of consideration. I believe that on this suggestion a new working theory of inheritance can be constructed that will explain the facts without recourse to the idea of "unit-characters," "pangenes," or any kind of character "bearers," in the sense of bodies or substances which are alone responsible for the development of a given character. It would be out of place here to attempt to present such a theory. I think, however, that an illustration of what I mean may be permissible. Let us suppose that a series of wireless stations, say in San Francisco, Denver, St. Louis and Washington, attempt to relay a message from the Pacific to the Atlantic. Now, if the St. Louis station should fail to do its part, the message would not arrive. In this case, we may not say that, if this station had done its part, it would have been *the* sender of the message. The relaying at that station is merely one of a chain of events that are necessary to the success of the experiment. But if St. Louis fails, then that station *is* responsible for the *failure* of the message to arrive at Washington.

The production of red pigment in the seed coat of the cowpea may possibly be a complex process in which every part of the living substance of the cell is concerned; but if a single cell organ which performs a necessary part of this process fails to play its part, then red pigment fails to develop. The cell organ whose failure to perform a usual function may thus be accountable for the lack of pigment formation might then be considered the "gene," as Johannsen calls it, for the

absence of red pigment; while the whole organism might be the gene for the presence of this pigment.

In order that the study of the physiological chemistry of pigment formation shall give results of the greatest importance to the theory of heredity, it would be an ideal condition if such work could be carried out by one who possesses a wide acquaintance with the facts and theories in both these sciences. But such men are not plentiful. The next best scheme would be a cooperative study of the subject by two men, one in each field. I am happy to be able to say that Dr. Bartlett has consented to take up the chemical end of this work in connection with my investigations of the genetic phases of the problem, and Professor Piper has promised to grow the material for such study. Gortner's important work in this field, in connection with Dr. C. B. Davenport's work on genetics, has already been mentioned. With all these investigations, and those of Miss Wheldale and Professor Bateson at Cambridge, it is to be hoped that we shall gain a somewhat more definite view of the nature of Mendelian factors.

W. J. SPILLMAN

THE PERUVIAN EXPEDITION OF 1912

THE Peruvian Expedition of 1912, organized under the auspices of Yale University and the National Geographic Society for the purpose of carrying on geographic and anthropologic exploration in Peru, will endeavor to continue and extend the work of the Yale Peruvian Expedition of 1911, utilizing the discoveries made then and continuing further along the same lines.

It is our purpose to pursue intensive studies in the region where reconnaissance work was done on the last expedition, taking advantage of the discoveries then made to guide the plans for this year.

The work planned for the expedition is as follows:

I. In topography:

1. To make a topographical map on a scale of 2 miles to the inch, with a contour interval of 100 feet, of the Cuzco basin.
2. To connect that part of the Vilcabamba survey made by the topographer of the 1911 expedition with his trans-Andean cross section from Abancay to Camaná.
3. To make a map of the so-called Vilcabamba country which lies north of Cuzco between and including the valleys of the Apurimac and Urubamba rivers. Some portions of this were finished by Mr. Kai Hendriksen, topographer of the 1911 expedition, but owing to the difficulties of the route he was only able to make a beginning.

Every effort will be made to complete the map of Vilcabamba, placing on it not only the ancient and modern sites, but also the data for further physiographical and geological study.

4. To map the routes connecting the later Inca capital of Vitcos with the rest of Peru.
5. To discover and identify the places mentioned in the Spanish chronicles and in the early accounts of Peru, particularly the places connected with the 35 years of Inca rule after the advent of Pizarro. As many of these place names have changed, it will be necessary to identify the places by a careful comparison of their situation and surroundings with the itineraries and descriptions given in the chronicles.

II. In geology:

1. To make a careful survey of the Cuzco basin and its vicinity, with special reference to the age of gravel deposits where human and other remains were found on the expedition of 1911.
2. To make a geological reconnaissance of the Vilcabamba country, continuing the work already begun.

III. In meteorology:

1. To establish and equip meteorological

stations at Cuzco and at Santa Ana, stations at which continuous observations may be made for several years, these observations to be supplemented by field observations taken by various members of the expedition wherever practicable.

IV. In pathology:

1. To study the various diseases throughout the region visited, and their geographical extent.
2. To study the effect of coca chewing.

V. In osteology:

1. To study the bone deposits in the Aya-huaycco quebrada where human and other bones were found on the 1911 expedition.
2. To collect osteological material not only in the Cuzco gravels, but also in the mountains of Vilcabamba.

VI. In forestry:

To make a reconnaissance survey of the Vilcabamba region between the Apurimac and the Urubamba valleys.

VII. In anthropology:

1. To take photographs and physical measurements of native types throughout the region visited, with particular reference to a study of the distribution of the more important groups.
2. To collect material for a study of the distribution of types of cranial deformation.

VIII. In archeology:

1. To make a thorough investigation of the region round about and north from Cuzco and Pisac, photographing, measuring and describing whatever architectural material presents itself.
2. To continue the investigation of the ruins discovered on the expedition of 1911.
3. To penetrate still further into the jungles of the Pampaconas Valley and beyond, to see whether any more remains of Inca occupation can be found.

The expedition will include a geologist, an osteologist, a surgeon, three topographers and three assistants, besides the director. The geologist will be Professor Herbert Gregory, Silliman professor of geology in Yale University, and the osteologist, Dr. George F. Eaton,

curator of osteology in the Peabody Museum of Yale University.

HIRAM BINGHAM,
Director of the Expedition

SAMUEL BUTLER AND BIOLOGICAL
MEMORY

THE present vogue of the books of Samuel Butler—not a great vogue but one fairly commensurate, perhaps, with the scientific worth and general interest of his writings—has led me to a rather critical reading of the four books and several scattered essays of this partly scientific, partly artistic, mostly iconoclastic, and wholly clever and epigrammatic modern namesake of the greater Samuel Butler of two centuries gone.

He finds himself dubbed in the British Museum Library catalogue as "philosophical writer," being alphabetically bestowed between "Samuel Butler, bishop" and "Samuel Butler, poet"; and in one of his essays tells a pretty story to account for his title.

The library catalogue is, as many will recall, printed and pasted in huge tomes, hundreds of them, and changes in its arrangement are not easily made. When our Butler found himself beginning to get into the catalogue he found also that he was getting mixed up with his namesake bishop and his namesake poet, and as yet he had no distinguishing title of his own. When he complained to the Library directors of his trouble it was pointed out to him that it was largely his own fault in not having sufficient distinction or distinctiveness to be classified properly. He must have a title. What was he, really? His writings were partly about Italian art, partly about the authorship of the *Odyssey*, partly about evolution and partly of the nature of stories. How was he to be distinguished? Had he any title? He replied, after meditation, that he was a Bachelor of Arts. The director pointed out that as far as his book titles were not actually confused with those of the bishop and poet, they were pasted in between theirs, and that if he were catalogued as "Samuel Butler, B.A.," the strictly alphabetical sequence of the catalogue

would be wronged. Could he not, perhaps, arrange to be a Master of Arts? Butler replied that he understood that Cambridge stood one a Master for five guineas, but he was not willing to go above three guineas ten! Well, anyway, was the answer, he must be "Samuel Butler, something, between *bi* and *po*!" So it was finally agreed that he should be "Samuel Butler, philosophical writer"—*phi* agreeing properly with the order in which he had already been irrevocably pasted!

Now this long digression, by way of introduction, from the subject of my letter, has after all a definite significance in relation to it. It has indeed, for me, at least, a double significance. It suggests something about British ways and something about the doubt as to how Samuel Butler's writings, even the four books about Darwinism, Lamarckism and biological memory, should be classified. Are they contributions to science, or to pure literature? Certainly, they are contributions to the gaiety of nations when they are not, as occasionally they are certainly are, contributions to that which makes the judicious to grieve. Whatever of sharpness in polemic one may tolerate in a critic of Darwinism, innuendo and really almost scurrilous personal attack on Charles Darwin one will not tolerate. And Butler comes to no less than this in his attempt to show Darwin's bad faith in a matter of the use of a certain freely modified translation of an account of Erasmus Darwin by Krause, in *Kosmos*.

Butler, though strongly anti-Darwinian (that is, anti-natural selection and anti-Charles Darwin) is not anti-evolutionist. He professes, indeed, to be very much of an evolutionist, and in particular one who has taken it upon his shoulders to reinstate Buffon and Erasmus Darwin, and, as a follower of these two, Lamarck, in their rightful place as the most believable explainers of the factors and method of evolution. His evolution belief is a sort of Butlerized Lamarckism, tracing back originally to Buffon and Erasmus Darwin. He is equally insistent on degrading the explanations of Charles Darwin, Wallace and Weismann, viz., the selection

champions, to their rightfully ignoble place of puerility and imbecility. And finally he is intent on reestablishing the factor of design in evolution. He holds strongly to a certain sort of teleology in organic change. Organisms make themselves what they are somewhat understandingly, as it were. They know what is good for them, and try to do it and be it.

Granted, now, that this man is a master of epigram, paradox, sophistication, argument and audacity, and of a literary style as animated and sparkling as it is bold, and you can fancy that his books make interesting reading to professed students of evolution and to scientific men—at whom he sneers and laughs—as well as to those readers “whose time is worth money,” whom he exalts and to whom he explicitly directs his writing.

The four books of this sort that were written originally some thirty years ago and that have been recently re-issued by Fiffeld in London and—I believe—Putnams in New York are: “Life and Habit” (1878), “Evolution, Old and New” (1879), “Unconscious Memory” (1880) and “Luck or Cunning” (1881). In 1890, in *The Universal Review* (London), he published three essays (really one in three parts) under the title “The Deadlock of Darwinism,” in which he reiterates the general conclusions and theories set out in detail in his earlier writing.

In addition to these four books, offered as direct contributions to evolution discussion, a much earlier book, called “Erewhon” (= Nowhere) (1872), contains in its pages of fantastic picturing and imagination the budding thoughts that later form the basis of his anti-Darwinism. Particularly in the chapter called “The Book of the Machines” are his ideas of design and his denial of chance in world evolution set out. This book has had a wide diffusion, and is the one which really gave him literary repute. It is a picturesque account of the life and philosophy of the non-existent Erewhonians, and its pages reveal the imagination of a Wells and the satire of a Bernard Shaw. Shaw, indeed, has strongly commended it, and Augustine

Birrell has called it the best satire since “Gulliver’s Travels.”

And I have not yet got to a word about “biological memory.” Well, it will take but few sentences to point out Butler’s relation to this subject. The fact that he used “Unconscious Memory” as title for one of his books shows the store he set by his notions about biological memory—notions that he undoubtedly developed independently, and that he believed, at the time he formulated them, to be wholly original with him. Butler’s theory that heredity and instincts are the results of, or are themselves, biological memory, was set out in detail in his first biological book, “Life and Habit” (1878). The book “Unconscious Memory” (1880) is chiefly devoted to recording his discovery that he had been antedated by Ewald Hering, whose address on “Das Gedächtniss als allgemeine Funktion der organisirten Substanz,” given before a meeting of the Vienna Imperial Academy of Sciences on May 30, 1870, he translates and prints in full. The book also contains a long translation from von Hartmann, and some discussion of it, to show that Hering’s and Butler’s theory of biological memory is not at all von Hartmann’s unconscious control. And it is in this book, too, that Butler (Chap. IV.) says his worst about Darwin.

As a matter of fact, Hering was not the first to have the conception of an explanation of repetitive phenomena in organisms on the basis of cell or molecule memory. Lamarck and Haeckel had both suggested such an idea. In our own country, Cope and Hyatt, not earlier, but undoubtedly each originally, expressed the essence of such a conception. Hyatt indeed coined the word “mnemogenesis” for use in connection with his ideas about heredity and instinct. But Hering was certainly the first to give the conception full form, to compose it of details, and to suggest a physical basis for it, viz., the reception and storing by the body protoplasm of vibrations coming from without, so that this protoplasm became actually changed in capacity by its

various, and especially by its repeated, experiences.

Then came Butler, and, without knowledge of Hering's ideas, and out of a conviction that Darwin's natural selection of fortuitous variations was an absurd explanation of such fit things as instincts and hereditary repetitions, and that Lamarck's explanation of modification of individuals by effort and intent, carried over into racial acquisitions by heredity, was a much better one but needed something else to make it complete, he re-invented the conception of biological memory and worked it out to its logical extreme. Just what this extreme is, and what the details of Butler's theory are, I leave to any of my readers interested to find out from Butler's books. For besides the interesting speculations of an intelligent and imaginative man about a subject that has, I am convinced, some real things in it to be found out some day, they will get from their perusal a gentle titillation of shock and amusement, such as the day's duty of "scientific reading" rarely brings.

Since Hering and Butler, have come, of course, Richard Semon with "Die Mneme" and its new, and perhaps useful, terminology for the older ideas, and lastly the blessing of Sir Francis Darwin on the whole idea, as well as on Butler himself, bestowed in his British Association President's address of 1908. But as it is Butler more than biological memory that this letter is meant to call attention to I may stop here. Butler died in 1902, and is only now coming to his hearing.

VERNON L. KELLOGG

LONDON,

February 24

THE DEATH OF NETTIE MARIA STEVENS

At a meeting of the faculty of Bryn Mawr College, held May 6, 1912, it was voted to make the following record in the minutes:

WHEREAS, the faculty of Bryn Mawr College has heard with sincere sorrow of the death of Nettie Maria Stevens, A.B. and A.M. of Leland Stanford Junior University, graduate scholar in biology in Bryn Mawr College 1900-01, president's European fellow 1901-02, resident fellow in biol-

ogy 1902-03, doctor of philosophy of this college in 1903, sometime research fellow in biology, Carnegie research assistant and Alice Freeman Palmer research fellow, and since 1904 as reader and then as associate in experimental morphology, a member of the teaching staff and of the faculty,

Resolved, that we, the faculty of Bryn Mawr College, desire to record our appreciation of her talent for research, of the skill and assiduity with which she carried on difficult investigations, achieving a success that placed her in the very front rank of students of science and gave her a world-wide reputation among workers in biology. No less would we recognize the faithfulness with which as a member of the faculty she responded to every call for her services in teaching or in any general work of the college. We deplore her loss. We honor her memory.

Resolved, that copies of these resolutions be sent to the relatives of Dr. Stevens, to the board of directors and to SCIENCE.

SCIENTIFIC NOTES AND NEWS

At the suggestion of the German emperor, the Berlin Institute for Infectious Diseases will be named in honor of Robert Koch.

THE faculty, students and alumni of the university of California will erect in the museum corridor of the new agricultural hall of the University of California a bronze bust in honor of Dr. Eugene W. Hilgard, emeritus professor of agriculture.

PROFESSOR GRASSET, on the occasion of the thirtieth anniversary of his professorship of medicine at Montpelier, was presented with his bust and a medal.

PHYSICIANS of Philadelphia have been invited to join in honoring the memory of Dr. John Herr Musser by subscribing to the memorial fund to be used to endow the social service department of the University Hospital, Philadelphia, of which he was the founder and president. The will of Dr. Musser provides that if the personal estate reaches \$240,000, the sum of \$15,000 shall be given to the University of Pennsylvania for the endowment of a fellowship in honor of the late Dr. Robert M. Girvin.

THE new medical laboratories for the two years' course in medicine given at the Univer-

sity of North Carolina were opened on May 8. These laboratories present a complete equipment for anatomy, physiology, pathology, histology, pharmacology and the other studies usually included in the first two years' course. Provost Edgar F. Smith, of the University of Pennsylvania, delivered the chief address. The honorary degree of LL.D. was conferred upon Provost Smith, Dr. Charles W. Stiles, in charge of the work of the Rockefeller Hookworm Commission, and Dr. Richard H. Lewis, formerly secretary of the North Carolina Board of Health and president of the National Health Association.

DR. W. P. BRADLEY, professor of chemistry at Wesleyan University, has been granted leave of absence for the year 1912-13, to organize a department of research for the United States Rubber Goods Company.

THE American Philosophical Society has appointed the following delegates to represent it on the occasions designated: The Hon. Charlemagne Tower, at the inauguration of John Grier Hibben as president of Princeton University, on May 11; Dr. Morris Jastrow, Jr., at the fourth Congress on the History of Religions, to meet in Leyden on September 9-13 next; Professor Edward W. Morley, of West Hartford, Conn.; Professor Marston T. Bogert, of New York, and Professor Theo. William Richards, of Cambridge, at the eighth International Congress of Applied Chemistry, to be held in Washington and New York, September 4-13 next.

DR. FRANZ BOAS, professor of anthropology in Columbia University and in the University of Mexico, has returned to New York after a winter in Mexico and has immediately sailed for England to attend the Congress of Americanists to be held in London beginning on May 27.

DR. GEORGE BYRON GORDON, director of the University of Pennsylvania Museum, has been appointed a delegate to represent the university at the Eighteenth International Congress of Americanists.

PROFESSOR GEORGE H. PARKER, Harvard University, gave the sixth lecture in the

course offered to the students in the department of biology at Trinity College, on the evening of May 2 with the subject, "The Nervous System."

MR. TALCOTT WILLIAMS, director of the School of Journalism of Columbia University, is giving the Phi Beta Kappa address at the universities of Wisconsin, Minnesota and Nebraska on May 6 to 9 on "The Old Learning and the New."

PROFESSOR JOSEPH JASTROW, of the University of Wisconsin, will give the commencement address at the Normal School, Emporia, Kansas, on June 5, and also addresses at the opening of the summer school there.

PROFESSOR LILLIAN J. MARTIN, of the psychological department of Stanford University, gave an address on "Ueber die Localisation optischer Vorstellungsbilder" at the Fifth Congress for Experimental Psychology, held in Berlin from April 16 to 19, 1912. Her address appears in full in the April number of the *Monatschrift für Psychiatrie und Neurologie*.

SPECIAL lectures will be given at Kings College, University of London, by Dr. F. W. Mott, F.R.S., on May 20, 27, June 3 and 10, on "Heredity considered from the Point of View of Physiology and Pathology."

THERE will be civil service examinations on June 5, for the position of agricultural propagator in the Philippine Service at a salary of \$1,600; for examiners of surveys in the field service of the Department of Agriculture, at entrance salaries ranging from \$1,200 to \$1,500, and for scientific assistants, qualified in farm equipment, in the Bureau of Plant Industry, at salaries of \$1,200 to \$1,400.

THE late Henry Iden bequeathed \$100,000 to Cooper Union, New York City, and among other public bequests \$10,000 each to the American Museum of Natural History, the New York Botanical Garden and the New York Zoological Society.

Two eggs of the Great Auk, as we learn from the London *Times*, were sold on April 17 at Mr. J. C. Stevens's rooms in King-

street, Covent Garden, the property of Lady Smyth, of Ashton Court, Somerset, who inherited them from the late Sir J. H. Greville Smyth. The finer of the two was purchased at an auction in Kent, and resold at Stevens's on April 24, 1894, for 180 guineas; it now brought 150 guineas. The second egg, which went for 140 guineas, was purchased with a number of sea-birds' eggs, many years ago, by the late owner, but nothing appears to be known of its earlier history. Both were bought by Mr. Ward. Sir J. H. Greville Smyth had another specimen of the egg (which was sold at Stevens's in 1888 for £225). This was presented by Lady Greville Smyth to the Bristol Museum. A "census" by Mr. Edward Bidwell, in connection with the Great Auk, shows that there are in existence and recorded 80 skins and 73 eggs.

THE Austrian government has purchased for about \$600,000 the only two radium mines at Joachimsthal which were owned by private individuals. It is estimated that the two mines will yield annually about 3 grams of radium. Plans are under way for the development of Joachimsthal as a resort for the treatment of disease by radium.

A GIFT of \$50,000 has been made by a donor who desires his name withheld for the purpose of furthering the work of the National Committee for Mental Hygiene. The same individual has agreed to give \$50,000 more, on condition that the sum of \$200,000 additional be secured. The *Journal* of the American Medical Association states that the purpose for which the committee was formed is the study of all matters connected with the commitment, care and after-treatment of the insane. Plans for the study of this subject have been carefully prepared, and it is intended to encourage the formation in the various states of allied but independent societies with similar aims to those of the national committee. A special subcommittee, of which Dr. William L. Russell, superintendent of the Bloomingdale Hospital, is chairman, has been formed to begin the work outlined, and an office has been opened in the

Germania Life Building, New York City. Dr. Thomas W. Salmon, of the United States Public Health and Marine-Hospital Service, has been granted leave of absence by the government to undertake this work and has been engaged to conduct the studies outlined by the committee. The newly elected officers are: president, Dr. Llewellys F. Barker, of Johns Hopkins University; vice-presidents, Dr. William H. Welch, of Johns Hopkins Medical School; Dr. Charles P. Bancroft, superintendent of the New Hampshire State Hospital, Concord, N. H.; treasurer, Otto T. Bannard, president of the New York Trust Company; chairman of the executive committee, Dr. George Blumer, dean of Yale Medical School; chairman of the finance committee, Professor Russell H. Chittenden, director of Sheffield Scientific School of Yale University; secretary, Clifford W. Beers, organizer of the National Committee for Mental Hygiene.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Charles Herbert Pratt, the Massachusetts Institute of Technology receives a large bequest to endow a Pratt school of naval architecture and marine engineering. The income of the estate is to accumulate until the sum of \$750,000 has been reached, though it may be used at the expiration of twenty-one years.

GOVERNOR FOSS has signed the bill passed by the Massachusetts legislature appropriating \$50,000 annually for five years to the Worcester Polytechnic Institute. The grant is to be extended for an additional five years if in the meantime the institute obtains \$350,000.

AN anonymous benefactor has given \$100,000 to Hamilton College for the erection of a new library building.

COLUMBIA UNIVERSITY has received from Mr. and Mrs. William R. Peters a gift of \$50,000 to establish a fund for engineering research in memory of their son William R. Peters, Jr.

A SECOND gift of \$25,000 to Brown University from Mr. John D. Rockefeller, Jr., is

announced. The endowment has now reached \$815,000 toward the desired million dollars.

APPROPRIATION bills for the College of Agriculture, Cornell University, to the amount of \$907,000, of which \$788,000 is immediately available, were passed by the New York legislature at its recent session and signed by Governor Dix. The Veterinary College received an appropriation of \$105,000, bringing the total up to \$1,012,000. Of the appropriation \$329,000 is for the erection of new buildings for the use of the departments of forestry, agronomy and animal husbandry; \$129,000 of this amount is not immediately available. There was reappropriated \$182,000 for the completion of work already under way; \$265,000 for the current expenses of the college, and \$141,000 in what is known as the supply bill.

THE Johns Hopkins School of Technology will be opened next fall, offering instruction in three branches, mechanical and electrical engineering and applied chemistry. A committee headed by Mr. R. Brent Keyser, president of the board of trustees, Dr. J. S. Ames, director of the physical laboratory, and Dr. William B. Clark, professor of geology, has made a trip to the educational centers of the north, where they consulted with a number of educators on plans for organizing the institution.

DR. JOHN GRIER HIBBEN, hitherto Stuart professor of logic, was installed as president of Princeton University on May 11. There were present President Taft, Chief Justice White and delegates from one hundred and seventy-one educational institutions. The oath of office was administered by Justice Pitney, and President Hibben made an inaugural address on the essentials of a liberal education. Degrees were conferred on President Taft and Chief Justice White. At the luncheon speeches were made by them and by ex-President Patton, of Princeton; President Lowell, of Harvard; President Hadley, of Yale; President Butler, of Columbia, and President Schurman, of Cornell.

DR. DAVID L. EDSALL has been elected to the Jackson professorship of clinical medicine in

the Harvard Medical School to fill the vacancy made by the resignation of Dr. Frederick C. Shattuck, under the retiring rules of the Massachusetts General Hospital. At the same time Dr. Edsall has been appointed to one of the two permanent medical services at that hospital. He is a graduate of Princeton and of the University of Pennsylvania Medical School. He was professor in that school until 1910, and since in the Medical School of Washington University, St. Louis.

THE trustees of Cornell University have made appointments and promotions as follows: C. G. Woodbury, professor of pomology; Hugh Charles Troy, professor of dairy industry. The following assistant professors were promoted to the rank of professor: J. A. Bizzell, in soil technology; W. A. Riley, in entomology; G. W. Herrick, in entomology; H. W. Riley, in farm mechanics, and H. E. Ross, in dairy industry. The following instructors were promoted to the rank of assistant professor: L. J. Cross, in agricultural chemistry; Robert Matheson, in entomology; George C. Embury, in entomology; Arthur L. Thompson, in farm management, and Ralph H. Wheeler, in extension teaching. Albert Edward Wells, superintendent of shops of Sibley College, was appointed assistant professor of machine design.

JOHN HARLAND KELSON, head of the department of applied mechanics at Case School of Applied Science, Cleveland, Ohio, has been elected professor of applied mechanics at the Worcester Polytechnic Institute, succeeding the late Professor E. B. Hancock.

THERE have been appointed in the School of Journalism of Columbia University, Dr. E. E. Slossen, of the editorial staff of *The Independent*, formerly professor of chemistry in the University of Wyoming, as associate, and Dr. Walter B. Pitkin, of the department of philosophy of the university, as associate professor.

At the University of Wisconsin, Dr. James B. Overton has been promoted from assistant professor of botany to associate professor of plant physiology, and Mr. Gilbert M. Smith

from assistant in botany to instructor in botany.

MR. E. N. ZERN, professor of coal mining at the University of Pittsburgh, has been recently appointed professor of mining engineering at the West Virginia University. Mr. George Grow has also been made assistant in the College of Engineering at the same institution.

HENRY LEIGHTON, formerly instructor in the school of mines, University of Pittsburgh, has been advanced to be assistant professor of economic geology, in charge of the departments of economic geology and ceramics.

MR. J. W. COBB, B.Sc., has been appointed to succeed Dr. Bone, F.R.S., as Livesey professor of coal gas and fuel industries at Leeds University.

DISCUSSION AND CORRESPONDENCE

THE OCCURRENCE OF STIBNITE AT STEAMBOAT SPRINGS, NEVADA

STEAMBOAT SPRINGS, Nevada, has been often cited as an example of a metalliferous deposit in the process of formation. Becker¹ demonstrated the presence of metallic sulphides in the waters flowing from the springs and described their occurrence in an amorphous condition in the spring deposits. He was unable, however, to find any of the sulphide minerals crystallized. Some years later Lindgren² announced the discovery of minute crystals of pyrite and stibnite in sand and gravel that had been brought up from the bottom of a prospect shaft penetrating the sinter. It was evident from the mode of crystallization of these minerals that they had been deposited from the heated waters of the springs.

During a recent visit to the springs a grayish mud was noted in the bottom of several pools at the northern end of the sinter terrace, about a half mile from the station. On examination under a microscope it was seen that minute acicular crystals of stibnite made up a large proportion of the mud. These were

usually very thin and, when perfect, shaped like the blade of a Roman sword with parallel edges and blunt point. The crystals were too minute for accurate measurement, but the forms observed were probably the brachy- and macro-pinacoids and a macrodome. The larger crystals were frequently split towards one end into a narrow fan of finer blades and many individual crystals were bent and curved. Usually the stibnite was segregated in felted balls and occasionally completely surrounded microscopic grains of sand, which had served as nuclei for the forming crystals.

The remainder of the mud was made up of diatom skeletons, fragments of chalcedonic quartz, kaolinized feldspar, and occasional flakes of mica and hornblende.

The water in the pools is very clear and limpid, with the exception of one unusually active spring where the suspended sediment is sufficient to make the water turbid. The temperature of the water in the pools in which stibnite was found ranged from 86° C. to 93° C., and averaged somewhat higher than that of the pools at the southern end of the terrace where the antimony sulphide is deposited as an amorphous precipitate.

Clark³ cites the experiments of Doelter showing that stibnite is soluble in water heated to 80° C., especially in the presence of sodium sulphide. Melville's⁴ analyses of the water of Steamboat Springs show sodium sulphide to be present. As the temperature of the springs in which stibnite was found is above that in Doelter's experiments, it is probable that the crystallization of the stibnite takes place as the heated waters approach the surface.

The complete envelopment of sand grains by the stibnite crystals presupposes free suspension in the water during the period of crystallization. The rounded form of the balls of felted crystals suggests that they formed under similar conditions. It is not unlikely that the stibnite crystallizes in the

¹ "Data of Geochemistry," U. S. G. S. Bull. 491, 1911, p. 603.

⁴ Mon. U. S. Geol. Survey, Vol. 13, 1888, pp. 347, 349.

¹ Mon. U. S. Geol. Survey, Vol. 13, 1888, pp. 342-344.

² *Trans. A. I. M. E.*, Vol. 36, 1906, pp. 27-31.

pool and is kept in suspension by the constant agitation of the rising water.

The formation of one of the minerals associated with ore deposits under conditions that may be observed is of more than passing interest and a closer study is in progress.

J CLAUDE JONES

MACKAY SCHOOL OF MINES,
RENO, NEVADA

CERIUM

If any mineral collection contains specimens of cerium ochre or yttrocerite from Bolton or any other Massachusetts locality, I should be obliged to the curator of such collection if he would inform me of the fact and give me briefly the history and description of the specimen.

B. K. EMERSON

AMHERST, MASS.

POPULARIZING SCIENCES

THIRTY years ago the incorporated city of San Diego, California, possessed a population of perhaps two thousand. Clergymen, lawyers, teachers, business men, working men, were alike members of the Society of Natural History, and its president, a physician, kept up the interest in the monthly meetings. Everybody came, bringing a rock or a shell or a bird or some object curious or rare, contributing to the little museum, and arousing discussion.

To-day a six-story concrete building is being erected on a lot given to the society for a home, one floor to be used for its museum and library, the other floors forming part of a hotel. With a present population of near 50,000, annual meetings are held by the society, which are generally attended by barely enough members for the election of officers. The library and museum are at a standstill. The meteorological records, begun by the society's president, are continued by a fully equipped station of the weather bureau of the U. S. Department of Agriculture—of which we sometimes hear boastful but seldom instructive remarks.

A marine biological station has been estab-

lished, under control of the state university, and given \$50,000 for a building—but the public rarely hears of any results, except of the occasional visit of some noted scientist, as heralded in the dailies.

A floral society now exists, and a botanical garden is proposed, to which nurserymen will sometime be invited to contribute from their commercial stock, but no strictly botanical work is in progress in the community, and the only attempt in fifteen years met with failure for lack of appreciation.

The city contains three private collections of shells, one of insects, one of birds, one or two of minerals, two botanists without herbaria, one meteorologist (in government employ), and a few others interested inactively in some phase of science, or about one naturalist to each five thousand people, which I have seen stated to be about the average number in the United States.

I recently visited one of the nearby grand ocean beaches, where the sea still breaks in spray over the rocks, as it did thirty years ago—but the pools that formerly concealed a wealth of beautiful wonders in animal and plant life have been scraped clean of their former treasures. Now and then a crab scuttles to safety. A hook and line sometimes brings one of the finny tribe from the deep—but boys and girls can hunt in vain for the many nature treasures that formerly lined the shores of ocean and nearby bay.

Children may still reap a treasure in wild flowers in springtime—by taking generous car rides and then walking—but they will look in vain in our paved streets for the trap-door spider's nest that I formerly watched, or for the miniature plants like the lichens that formerly freely decorated barren spots of earth.

With the increased cost of living, with leaps and bounds in the growth of our commercial life, with a corner lot that cost \$5,000 ten years ago now yielding an annual rental of \$6,000 to its purchaser, can you expect to find nature study gaining ground!

Science as a study is becoming too complicated for a layman to take part in the active

fashion of former times, and it is becoming yearly more expensive and difficult for one in private life to keep abreast of the times even by specializing in a restricted field.

And opportunities for one to do good scientific work with any chance of earning expense money are exceeding rare—unless a salaried position is secured in advance.

The increased number of scientific and educational institutions apparently fail to give equal facilities with the past to the independent youthful student. And the increase in volume of literature renders it impossible for any one not connected with some wealthy institution, or with large private means, to keep posted on proposed changes in nomenclature—to say nothing of the new discoveries being made.

There is no decrease in the interest of the general public in scientific work, but the existing state of affairs is probably due chiefly to expansion and greatly increased activity, resulting in a mass of unassimilated data and museums bursting beyond the bounds set by their founders.

C. R. ORCUTT

SCIENTIFIC BOOKS

A Cyclopedia of American Medical Biography, Comprising the Lives of Eminent Deceased Physicians and Surgeons from 1610 to 1910. By HOWARD A. KELLY, M.D. Illustrated with Portraits. Two Volumes. Philadelphia and London, W. B. Saunders Company. 1912.

This work, handsome in typography and execution, and containing over twelve hundred biographies of prominent deceased American physicians, written, for the most part, in clean-cut style by various competent hands, marks a distinct advance upon any of its predecessors in the same kind. Of the earlier dictionaries of American medical biography, those of Thacher (1828) and of the eminent surgeon S. D. Gross (1861) have a definite historic value, but the separate lives are usually too long, Thacher's, in particular, being surcharged with that florid, stilted spirit which, as Dr. Holmes wittily said,

"has chewed the juice out of all the superlatives in the language in Fourth of July orations"; while the generous-minded Gross, incapable of saying anything unkind about his colleagues, was perhaps lacking in a right critical sense for that very reason. On the other hand, the later works—those of Atkinson (1878), Stone (1894) and Watson (1896)—abound in shorter biographies, but are, in the main, only directories of contemporary names. Dr. Kelly's *Cyclopedia* strikes a happy balance between the extremes of florid encomium and mediocre choice, consisting, in the main, of compact sketches of the lives of medical men who have "done things," and is thus a genuine contribution to medical history. Some of these worthies have described new diseases, have introduced new drugs, new operations or therapeutic procedures, or have otherwise contributed to the elevation of American medicine as chemists, botanists, zoologists, bibliophiles, military and naval surgeons or leaders in hygienic and social movements. The editor's plan in getting up this work was two-fold: one group of his co-workers took up the physicians who were of local importance as practitioners; the other group took care of those who are of scientific importance in relation to the specialties which they helped to advance. Some of the former class might seem at first sight of little consequence, yet it will appear that as teachers, organizers of schools and hospitals, pioneers in hygiene, whether in Canada, Mississippi or the far west, they have their place in the development of earlier American medicine, even though unknown in Berlin, St. Petersburg or Vienna. Professor Horatio C. Wood, the well-known therapist, relates that he was once asked by an eminent European authority for a list of the professors of his specialty in America. Upon receiving some forty or fifty names, the astounded savant replied: "In God's name who are these people? I never heard of more than one or two of them." Identical sensations are experienced in looking over the pages of Hirsch's "Biographisches Lexikon der Aerzte," that monument of

¹ *Therap. Gaz.*, Detroit, 1911, XXXV., 92.

German industry, especially when we come to the Meyers, Müllers, Schmidts and Schmitts. In other words, many able physicians are of that exclusively local importance so well described in Sainte Beuve's famous reply to Matthew Arnold: "He was important to us."

The introduction to this Cyclopedia consists of a series of valuable historical sketches on the development of different branches of medical science in America, notably those of Dr. Charles R. Bardeen on anatomy, Dr. Martin B. Tinker on surgery, and the histories of gynecology and obstetrics by Dr. Kelly himself. Few specialists seem to know or care so little about the history of their subject as gynecologists, probably because its development has been mainly technical and instrumental. In this regard, Dr. Kelly's sketch may be pronounced the best history of American gynecology that has yet appeared. It is memorable that operative gynecology, which had no existence as a specialty before the nineteenth century, is largely of American origin—in the first instance, an expedient to repair the sequels of backwoods obstetrics, and that its principal founders—McDowell, Marion Sims, Battey, Nott, Emmet, Bozeman, Gaillard Thomas—have been natives of the southern states.

Of especial historical interest are the notices of the colonial pamphleteers on smallpox and vaccination, the eighteenth century leaders (Rush, Morgan, Shippen, Physick), the pioneers in the surgery of the vascular system and the joints, the discoverers and exploiters of surgical anesthesia, the medical botanists, the medical jurisconsults, the important physicians of the Philadelphia group, and such later worthies as William Pepper, Walter Reed, Nicholas Senn or Elizabeth Blackwell. A biography of Hezekiah Beardsley, who, in 1788, described congenital hypertrophic stenosis of the pylorus, appears for the first time. There have been some omissions, perhaps unavoidable in works of this kind, in particular, Bowditch the physiologist, Bigelow the surgeon and the clinicians James Jackson and John K. Mitchell. Of John C. Otto, of Philadelphia, who, in 1803, first described

hemophilia,² perhaps "*Non dat quod non habet.*" It is doubtful if Ricord and Brown Séquard can properly be included among Americans, since both were of French origin and all their life-work was identified with French medicine. On similar grounds, the omission of William Charles Wells, of South Carolina, memorable to physicists for his "Essay on Dew," seems not improper. A few points in priority in Dr. Tinker's surgical introduction may be noted. It is frequently asserted that Dr. Dixi Crosby, of New Hampshire, was the first to perform the inter-scapular-thoracic amputation (excision of arm, scapula and clavicle) in 1836. It had already been performed by Ralph Cuming, an English naval surgeon, in 1808.³ Dupuytren cured a popliteal aneurism by compression in 1818,⁴ long before Jonathan Knight (1845) or O'Bryen Bellingham (1847), although Knight is undoubtedly entitled to the credit of doing this by digital compression. If Dr. Heine Marks really sutured a wounded heart before Farina and the Italian surgeons, it remains for him to prove it, as he mentions not a stitch of it in his published paper.

These volumes are embellished with many interesting portraits, those of Asa Gray, Fordyce Barker, Dewees, Agnew, Senn and Leidy being particularly good, while those of John Morgan, Physick, Horner (of Horner's muscle), Caspar Wistar, J. P. Mettauer and Willard Parker are probably copied for the first time. Many of the biographies have preserved traits of eccentricity in medical men who happened to be oddish, more especially those from the piquant pen of Miss Davina Waterson. The following sentences of Joseph Leidy on introducing himself before a lecture are an example of the utter freedom from swagger and snobbery which distinguishes the true man of science:

My name is Joseph Leidy, doctor of medicine. I was born in this city the ninth of September, 1823, and have lived here ever since. My father

² *Med. Repository*, New York, 1803, VI., 1-4.

³ *Lond. M. Gaz.*, 1829-30, V., 273.

⁴ *Bull. Fac. de méd. de Par.*, 1818, VI., 242.

⁵ *Med. Fortnightly*, St. Louis, 1893, III., 44-46.

was Philip Leidy, the latter, on 3rd street above Vine; my mother, Katherine Mellick, but she died a few months after my birth, and my father married her sister Cristina, who was all in all to me, the one to whom I owe all that I am. At an early age I took great delight in natural history, of which I have reason to think I know a little, and a little of that little I propose to teach you to-night.

One does not need to glance at the splendid head on the opposite page to realize that this great naturalist, whose "Rhizopods of North America," is one of our finest biological classics, was *echt*, in the exquisite Emersonian sense of living "from a great depth of being."

There are a few typographical errors here and there, but these things are of little consequence in a work which deserves to be in the library of every physician interested in the medical history of his country, and which will undoubtedly prove a valuable reference book in working scientific and public libraries.

F. H. GARRISON

SURGEON GENERAL'S LIBRARY

A Revision of the Cotylosauria of North America. By E. C. CASE. Washington, Carnegie Institution, Publication No. 145. 1911. Pp. 122, 14 plates.

It is now more than thirty-six years since the first Permian or Permo-Carboniferous reptiles were made known from North America by the late Professor Cope, who until his death twenty years or more later published at frequent intervals papers dealing with Paleozoic land vertebrates, coming chiefly from the famous deposits in northern Texas. As a pioneer, his work, here as elsewhere, was, of necessity, largely based upon fragmentary and imperfect material, material largely obscured by an obdurate matrix that only long and skilful preparation could remove. Few, if any, forms were known to him in anything approaching perfection or even completeness. As an inevitable result he left the subject in more or less confusion, notwithstanding the many important facts which he discovered. Many of his types were never figured nor even adequately described. In more recent years, beginning with Professor Case's collection in

Texas in 1897, the additions to our knowledge of these old land vertebrates made by him and others have been very considerable and of profound importance in paleontology. But much of the confusion and doubt regarding many of the original types, for the most part preserved in the American Museum of New York City, could only be removed by a careful revision of the whole group, based upon original specimens. This Professor Case has given us of the so-called order Cotylosauria in the present paper. At the present time there is, perhaps, no group of vertebrates of deeper interest to the student of evolution than the primitive reptiles and amphibians of the later Paleozoic, the forms from which all later vertebrates, save the fishes, have been derived. The many problems of the evolution of the Amphibia, and the origin and "radiation" of the Reptilia, are, until other fields have been discovered, dependent chiefly if not almost wholly on the Permo-Carboniferous deposits of Texas and the Rocky Mountains. No classification of the reptiles and amphibians will ever command any great degree of respect until these faunas have been well worked out; and, inasmuch as many of the problems of these groups are fundamental ones in many respects for all higher vertebrates, the interest attached to such studies as the present may be easily understood.

Professor Case did a very acceptable piece of work in his revision of the Pelycosauria, or the higher reptiles of the same fauna, published a few years ago. In the present work he has revised systematically and morphologically the numerous genera and species that have been proposed of the cotylosaurian reptiles, a group usually called an order though not distinguishable by very important characters from the Pelycosauria or Theromorpha. The chief value of the paper is the information given of the fragmentary and often unrecognizable types of Cope, as interpreted in the light of a more advanced knowledge of the group, by descriptions, comparisons and illustrations. Not much new material has been described nor have many new forms been added that had not been published by himself

or others previously. He divides the order into four suborders, the Pareiasauria, Procolophonia, Diadectosauria and Pantylosauria, the last two new. While these terms will be convenient, the present writer doubts whether the distribution proposed of the families is really the best, or whether indeed there is really any need of classificatory terms between the family and order at present.

Dr. Case urges, what has now become apparent, that the Cotylosauria are far from being the beginning of the reptilian stem, that forms so diverse as those we already know from the base of the American Permian must have been long years in developing. Nevertheless they approach that beginning relatively close, and, until the actual beginning is found, must suffice as the basis for the classification of all later reptiles. The writer can not agree with the author in the interpretation of some of the cranial elements in these reptiles, but as that is a subject about which no two authors agree, Dr. Case's views are perhaps as good as those of others. Nor is he assured that the forms *Eosaurus* and *Saurus* really belong among the Cotylosauria. And, as regards the attachment of the ribs in these "microsaurian" forms, they are really not different from those of all the known Permo-Carboniferous reptiles.

The work has been brought out in excellent shape by the Carnegie Institution, and it will long remain as an indispensable one for all students of the early reptiles.

S. W. WILLISTON

The Home-life of the Osprey. By CLINTON G. ABBOTT. London, Witherby & Co. 1911. Pp. 1-56; 32 mounted plates.

This volume forms the third of an admirably planned series, designed to present, through the aid of pictures and a brief text, the most interesting facts about celebrities of the bird world. The American osprey is worthy of this distinction, and the field-work; upon which this biography is based, although "necessarily limited to the brief opportunities of a business man," has been prepared with commendable care. We venture to express the

hope that more business men, and representatives of the professions may in time come to reap the profits and enjoyments which an intelligent interest in natural history affords.

The author's studies were made on the coast of New Jersey, at Great Lake, North Carolina, and at that world-famous preserve for ospreys, Gardiner's Island, New York. This tract of 3,000 acres is three miles from the eastern end of Long Island, and is probably unique in that, as we are told, it has been in the possession of the same family for nearly 300 years, or since the time of its purchase from the Indians for "ten coats of trading cloth." It is now maintained as a general farm and preserve, with "a pleasing succession of rolling meadows, thick coverts, stately trees, lakes and grassy marshes." This remarkable island has been the immemorial home of fish hawks, and is now thought to harbor upwards of 200 of their massive nests. Moreover, these gigantic structures are reared with absolute freedom, in almost every conceivable situation, upon the shifting sands of the beach, upon great rocks, in trees or even upon the gable end of a deserted barn or shed. The author shows a nest built on a fence-post and another on a telegraph pole, while in parts of Connecticut these neighborly birds have often taken kindly to the old cart wheel reared aloft for their special benefit on the top of a high pole.

Ospreys are model parents, friendly to man, and exceedingly attractive at all times. Many characteristic attitudes in both young and adult are described and figured by Mr. Abbott, such as flying up the wind in returning to the nest, detouring, repeating and often alighting on any favorite perch other than the nest. Like other birds, they hold closely to the perch, upon which habit has fixed.

Mr. Abbott never saw the parents sprinkle their young with water, but Allen, an earlier observer of this species, found that they occasionally brought fresh seaweed to their eyrie. "Similarly, I have sincere doubts," says the writer, whether the "grateful shade, over the young, of the parent's outstretched wings, is not more accidental than inten-

tional." As a result of long observation we know that shielding is a common practise with nesting birds. It is probably something more than a heat-reflex, since it is most characteristic of the later period of nest-life, when it succeeds the more familiar brooding "habit." This spreading over the young, or shielding attitude, is useful like the other instincts, but whether it is "intentional" or not is quite aside from the main question. We might even have to qualify any sweeping statement that *brooding* was intentional. "Spreading," when away from the nest, is undoubtedly a reflex, and is often apparently due to heat, but birds will spread in a similar manner to dry off when wet.

Young ospreys are fed at long intervals, not oftener than twice or three times a day, though the rate of feeding possibly may vary somewhat with age. At one nest which the author carefully watched, meals were served at 7 P.M. and at 4.15 A.M. and 7 P.M. on the following day. At night the male guards the nest, while its mate broods.

The osprey is said by fishermen to descend four or five feet in the water to strike the flounder, which is often seen in its talons. Fish are always carried head foremost, either the bird's right or left foot being directed forward. It will be interesting to note that the largest capture which Audubon directly observed, was a weak-fish, weighing upwards of five pounds. This bird, he remarked, was barely able to rise from the water, and when shot at it immediately dropped its quarry. Moreover, it was this large and perfect specimen which Audubon introduced into his plate.

Nest-building begins in May and additions to the structure are made throughout the season. A nest once built and occupied is commonly held as a rightful and individual possession, and the structure tends to increase in bulk from year to year. The writer, however, finds that this is not invariably the case, and much more exact knowledge on the history of such nests is greatly needed. A nest of the osprey which was removed from Gardiner's Island to the New York Zoological Garden

weighed 400 pounds and it is thought that the largest nests may even reach the weight of half a ton. At this island the eggs are laid early in May, and two to three in number. Incubation lasts from 24 to 28 days, the young ospreys emerging in close furry down. Nest-life lasts from 5 to 6 weeks, and is over by early August.

We do not for a moment believe that ospreys or any other wild birds suffer the "mental anguish" about their young which the writer generously attributes to them, but we are not disposed to be overexact with work conscientiously done, and especially when a good moral lesson is enforced.

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A Text-book of Botany for Colleges and Universities. By members of the Botanical Staff of the University of Chicago, JOHN MERLE COULTER, Ph.D., Professor of Plant Morphology; CHARLES REID BARNES, Ph.D., Late Professor of Plant Physiology; HENRY CHANDLER COWLES, Ph.D., Associate Professor of Plant Ecology. Vol. II. Ecology. New York, Cincinnati and Chicago. American Book Company, octavo. Pp. x+485 to 964+17.

A little more than a year ago the present writer noticed the first volume (Parts I. and II.) of this notable contribution to the American text-books of botany (SCIENCE, January 6, 1911), and suggested the probable early appearance of Part III. This saw the light about the holidays, and has been before the botanists of the country long enough to have already taken its place as one of the standard texts in its special department of botany. No doubt the first feeling of every botanist was one of surprise at the quite different mode of treatment given to the subject from that which has heretofore been accorded it. Some things hitherto regarded as ecological are entirely left out in Dr. Cowles's treatment or given very little emphasis. No doubt many an "ecologist" will rub his eyes as he looks about him in certain chapters for something familiar.

In an introductory chapter the author discusses his problem in such manner as to help us to see it from his point of view, starting with the remark that "ecology is a science in its beginnings." A little later he says "nor is it possible as yet to mark out its limits, for it overlaps to a greater or less degree every other field of biology and of physiography and geology as well." In spite of these difficulties he ventures a definition of ecology as "that phase of biology that endeavors to explain the origin, variation and rôle of plant or animal structures, and the origin and variation of plant or animal associations." This introductory chapter ought in fact to be very carefully read and reread by the student who wishes to know what it is that Dr. Cowles is putting before him under the name "ecology," for it will be evident very early in the use of the book that it is not at all like those that have preceded it, which means that this "ecology" is not the "ecology" of many other authors.

The general plan of the book may be seen in an enumeration of the contents of the eight chapters, as follows: (I.) Roots and Rhizoids; (II.) Leaves; (III.) Stems; (IV.) Saphrophytisms, and Symbiosis; (V.) Reproduction and Dispersal; (VI.) Germination; (VII.) Plant Associations; (VIII.) Adaptation. If now the student will read carefully any of these chapters he will find that they deal almost entirely with structure and behavior, and it appears to be the author's deliberate purpose to present these as the material upon which the beginner in ecology is to work. That is, Dr. Cowles bases ecology upon morphology and physiology, just as some of us have been insisting for these past years during which a certain type of ecologists were leading wholly unprepared young people into hazy observations in the field.

It is noticeable that the author has pretty fully eliminated teleology, which had become so conspicuous in the ecological writings of some botanists, reminding one in extreme cases of the botany of the early part of the nineteenth century. This revival of teleology by the younger generation was not a little

disquieting to the older botanists, who rightly felt that it was a backward step in the science to return to a view or doctrine that had only so recently been abandoned. In Dr. Cowles's book there is no conscious leaning toward teleology, and for this scientific men owe him a debt of gratitude.

In like manner the author has subordinated the geographical phases of the subject, giving some portions scant notice. He has chosen to emphasize the plant individually, rather than the mass of individuals constituting a particular community of plants. This no doubt contributes to clearness and definiteness and there can be no question that the students who approach ecological studies from this side and in this manner will have much more lucid notions on the subject than those who were taken directly into the field for the study of "vegetation" and "formations." It will be interesting to see what effect this presentation of ecology will have upon its study in high schools and the smaller colleges, where too often it had degenerated into rapid lectures on the general aspects of the vegetational landscape much after the fashion of those formerly given to young ladies who "took botany" in the old-time female seminaries of a century ago.

One of the most helpful and suggestive chapters is that on Saphrophytism and Symbiosis (IV.), dealing as it does with all phases of the structural and physiological relation of the two organisms concerned. The treatment here is clear, and well calculated to lay a solid foundation in the mind of the beginner.

In the fifth chapter (Reproduction and Dispersal), while by far the greatest attention is given to these phenomena in the flowering plants, the subject is introduced by twenty pages on the behavior of the lower plants, the author's idea evidently being that even lower plants are worth while ecologically, especially as they are simpler and more easily understood. The treatment throughout the chapter has an air of freshness that is gratifying, much of the matter having been developed by the author in connection with his class work.

The short chapter on plant associations,

eight pages in all, will be disappointing to old-time ecologists, to whom, however, its brevity should be a suggestion that they have hitherto given overmuch emphasis to this phase of the subject.

A thoughtful chapter on "adaptation," in which the author gives his personal views on the subject, closes the book in such a manner as to leave the student in a properly humble state of mind, since it makes it clear that many of the "cock sure" conclusions of yesterday are improbable, or quite impossible.

A most useful, ten-page appendix contains a classified bibliography which will prove very useful to the student who wishes to go farther than the study suggested in the text.

CHARLES E. BESSEY

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SPECIAL ARTICLES

THE PHOTOELECTRIC EFFECT

READERS of SCIENCE may be interested in the following brief summary of some of the principal results of an investigation of the magnitude and distribution of the total kinetic energy of the electrons emitted when light falls on metals, considered as a function of the frequency of the light and of the nature of the metal. A fuller account of the investigation was communicated to the meeting of the American Physical Society at Boston on April 27.

Monochromatic ultraviolet light of various wave-lengths from a quartz-mercury arc lamp was allowed to fall on a small strip of the metal to be tested placed at the center of an exhausted conducting sphere. Measurements of the currents against various opposing potentials enable the distribution of the energy among the emitted electrons to be obtained directly. The experimental results may be analyzed and exhibited graphically by plotting the number of electrons having a given energy against the energy. These curves are nearly symmetrical about the axis of mean energy. The mean energy is very close to the most probable value of the energy. The probability of an electron having energy within a

given range changes very rapidly in the neighborhood, both of the maximum energy and of zero energy. The maximum energy, and also the range of energy, of the electrons emitted by light of a given frequency is approximately a linear function of the frequency.

For different substances the relation between the mean energy T_v and the frequency v of the exciting light is found to be $T_v = k_1(v - v_0)$. For sodium, magnesium, zinc, aluminium, tin and platinum $k_1 = 2.9 \times 10^{-27}$ erg. sec. v_0 is a constant characteristic of the substance. The above formula is a particular case of a more general relation $T_v = v\phi(v_0/v)$, where ϕ is a universal function of the argument, which was deduced theoretically by one of the writers. According to the theory the values of v_0 should be calculable from Planck's radiation constant h and the intrinsic potentials of the substances. The calculated values of $\lambda_0 = c/v_0$ are compared with those given by the photoelectric measurements in the following table:

	Na	Al	Mg	Zn	Sn	Bi	Cu	Pt
λ_0 (calculated)....	52.6	36.0	34.6	33.3	31.0	29.4	28.0	27.3
λ_0 (photoelectric)	57.0	39.5	36.5	36.1	33.8	33.1	29.7	29.0

Our measurements of the maximum energy T_m are probably less accurate and certainly more irregular than those of the mean energy; but they are all fairly near the linear relation $T_m = k_2(v - v_0)$. The values of v_0 are the same as before and k_2 is very near to 6×10^{-27} erg. sec. k_2 is thus about 10 per cent. less than Planck's constant h . We do not, however, wish to emphasize this difference, pending further investigation, as we realize that the accurate measurement of the maximum energy is a rather difficult problem. Bismuth and copper appear to have smaller values of both k_1 and k_2 than the other metals, but here again it is possible that further research will remove the difference.

If the laws which we have found to connect the frequency of the light with the maximum and mean energy of the liberated electrons hold up to the highest frequencies, it follows

that the frequency ν of Röntgen rays may be obtained from either of the equations

$$\nu - \nu_0 = \frac{T_v}{2.9} \times 10^{27} = \frac{T_m}{6} \times 10^{27},$$

where T_v is the mean energy and T_m the maximum energy of the electrons emitted when Röntgen rays fall on a metal. For these high frequencies ν_0 may be neglected compared with ν .

Our results are favorable to a theory of the photoelectric effect of the type of Einstein's¹ combined with the hypothesis that the difference in the work P for different substances is determined by the contact difference of potential.

O. W. RICHARDSON

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PRELIMINARY NOTE ON THE OCCURRENCE OF A SEX-LIMITED CHARACTER IN CATS¹

THE problems offered by so-called "sex-limited characters" have lately been attacked by several investigators who have found in many of the cases a possible explanation of the observed phenomena by considering one of the sexes a Mendelian homozygote for the "sex-producing" factor, while the other sex is considered a heterozygote.

The sex-producing factor is commonly designated by X , its absence by $-$. Thus one sex would be homozygous, XX , and the other would be heterozygous, $X-$. Certain cases have been found in which experimental results indicate that the female is homozygous, XX , while the male is heterozygous, $X-$, while in other cases the facts are best explained on the hypothesis that the female is heterozygous, the male homozygous. Interest increases as sex-limited characters are found in the higher animals, the inheritance of which follows one or the other of these formulae.

It has long been known that "tortoise shell" (a blotching of black and yellow, or

blue and cream) occurs in cats, in a vast majority of cases in the female sex. Doncaster² (1904) attempted to ascertain whether tortoise shell could be considered as a sex-limited character whose appearance conformed to the then existing hypotheses of sex-inheritance. He came to the conclusion that "tortoise" was merely the female form of heterozygote obtained in a cross between orange (yellow) and black animals. The male form of "heterozygote" was orange in certain crosses. Thus he found that (1) orange female \times black male gives tortoise females and orange males, but the reciprocal cross (2) black female \times orange male gives tortoise, black (and probably orange) sexes not stated. This last-named cross is crucial, for in it is contained the evidence that the male "heterozygotes" between orange and black are *not always orange, but may be black*. The writer has, in a very small way, carried on this cross. Thus four black females crossed with the same orange male have given a total of 15 young; of these 7 were males, *all being black*, and 8 were females, *all being tortoise*; no "orange" animals appeared. Here there is evidence that the cross of orange male \times black female produces male offspring, *all of which are black*, while Doncaster's evidence shows the reciprocal cross to produce male offspring, *all of which are orange*.

We must, therefore, suppose a reversal of dominance to occur in the reciprocal crosses unless we can use the hypothesis of sex-limited inheritance.

If we adopt, tentatively, the hypothesis that the female is a homozygote, XX , and the male is a heterozygote, $X-$, and if we suppose that black, B , is always coupled with the sex-producing factor, X , we should conclude that the black female is of the gametic constitution, BB , and that the black male is of the composition $B-$.

The yellow male lacks the factor for the production of black pigment in the coat and is of the gametic composition $Y-$, while the

¹ *Ann. der Physik.*, Vol. 17, p. 146, 1905.

² From the Laboratory of Genetics, Bussey Institution.

² *Proc. Camb. Phil. Soc.*, XIII, Pt. I, p. 35, 1904.

yellow female is YY . The constitution of these four parent forms would then be: BB , black female; $B-$, black male; YY , yellow female; and $Y-$, yellow male.

If then we make the cross yellow male, $Y-$, \times yellow female, YY , all the young should be yellow, one half being males and one half females. In this cross 5 young have been obtained, 3 males and 2 females, *all yellow*.

If we make the cross black female, BB , \times yellow male, $Y-$, we have in F_1 two types of individuals, viz., BY , tortoise females, and $B-$, black male. Theoretically these two types should be formed in equal numbers; actually the tortoise females are 8, the black males 7. The reciprocal cross is yellow female, YY , \times black male, $B-$; F_1 has two types of individuals, viz., BY , tortoise female, and $Y-$, yellow male. This expectation coincides with the facts observed by Doncaster. We have, however, an important cross under way which must be carried out more fully before the hypothesis, given above, can be considered as proved. This mating is: tortoise female, BY , \times yellow male, $Y-$. The expected result is BY , tortoise females; YY , yellow females; $B-$, black males; and $Y-$, yellow males. One litter has been obtained from this cross; it contained one tortoise female, one black male and three yellows (dead), the sex of which was unfortunately undetermined before the caretaker discarded them. It is interesting to note that Doncaster cites this mating as producing "blacks, tortoises and oranges," though he does not record the sexes.

The cross tortoise female \times black male has been recorded by Doncaster. It gave tortoise females, orange males, black females and black males. By the hypothesis here suggested this is to be expected. Thus tortoise female, BY , \times black male, $B-$, should give BB , black females; $B-$, black males; $Y-$, yellow males; and BY , tortoise females.

Male "tortoise shells" occasionally occur, and it seems probable from their rarity that they are due to some distinct mutation such as that which produces tortoise guinea-pigs,

and not to heterozygosis between black and yellow. Theoretically, if such were the case, tortoise females of a similar nature might be produced. Such animals would be indistinguishable externally from the common form of "tortoise," but would differ in gametic composition, and therefore in their behavior in crosses.

So far as first-hand evidence goes the observed experimental facts are best explained by the hypothesis outlined above, which considers the factor for black coat color in cats to be linked with the X element, and therefore to be sex limited. Doncaster's suggestion that tortoise is merely the female heterozygote obtained in crosses between yellow and black would not explain the fact that reciprocal crosses of black with yellow produce males differing in color, one cross producing black males, the reciprocal cross producing yellow males. Indeed the last-mentioned fact in itself makes the case unique among mammals. If, then, the hypothesis of "sex-limited" characters outlined above is found to be substantiated by the cross, tortoise female \times yellow male, we shall have established a case of the same general character as those described by Morgan as occurring in *Drosophila*. Further experiments bearing upon the matter are in progress.

C. C. LITTLE

April 23, 1912

THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual general meeting of the American Philosophical Society was held in the rooms of the society at Philadelphia, April 18 to 21 inclusive, and constituted perhaps the most notable series of sessions ever held by the society. The papers were all of a high order of merit and presented in many cases for the first time the results of original investigation by the authors.

The meeting was opened on Thursday afternoon, President W. W. Keen, LL.D., in the chair, when the following papers were read:

Some Former Members of the American Philosophical Society: THOMAS WILLING BALCH.

The writer said that besides Franklin, the founder of the society, Washington, Jefferson and Cleveland were members. Many other political

men were members: John Dickinson, Albert Gallatin, De Witt Clinton, Alexander James Dallas, Thomas Francis Bayard and Carl Schurz, for example. The painters, Benjamin West, Charles Wilson Peale and Thomas Sully, belonged to the society. Of jurists, John Jay, John Marshall and Roger Brooke Taney were members. Among others whose names are on the roll of the society were: Joseph Bonaparte, King of Spain; Louis Philippe, King of the French; George Gordon Meade, the victor of Gettysburg; Commodore Wilkes, Bishop Charles Magnus von Wrangel, of the Church of Sweden; the Rev. John Witherspoon, of the Church of Scotland and president of Princeton. Among publicists, John Stuart Mill was a member, as also Noah Webster, de Tocqueville, Henry Wheaton, President Woolsey of Yale, Sir Henry Sumner Maine, Henry Charles Lea, Dupont de Nemours, Michel Chevalier. The writer showed that the society had recognized all knowledge in choosing its members.

The Diary of a Voyage to the United States, by Moreau de Saint Méry. STEWART L. MIMS. Introduced by Mr. J. G. Rosengarten.

Mr. Mims told the story of his good fortune in finding the diary in the Colonial Archives at Paris, where it had lain covered with dust, all but unnoticed and forgotten, for three generations. The author of the diary was born at Fort Royal, Martinique, in 1750, went to Paris at nineteen to study law and returned to Cap Français (to-day Cape Haiti) in the French colony of St. Domingo, where he practised law for eight years and was then elected to the Conseil Supérieur. The task of codifying the laws of St. Domingo called him back to Paris, where he published successively, from 1784-1790, the six volumes of his famous collection of laws concerning the French West Indies. At the outbreak of the French Revolution he became an ardent champion of the Revolutionary cause. He was made one of the electors of Paris, who governed France during the space of one month. It was as their president that he was "King of Paris during three days." With the accession of Robespierre to power Moreau was forced to flee from Paris into Normandy and later to Havre, whence he took ship for the United States on November 9, 1793. Owing to strong head winds and many storms, his vessel did not reach Norfolk before March 8, 1794. He remained as an exile in this country until August, 1798, when he returned to France.

It is of this sojourn in America that the diary

records the story. After calling attention to the value of certain passages where the author records his impressions of such cities as Norfolk, Baltimore, New York and Philadelphia, and to other passages containing the author's comments upon such public men as Washington, John Adams and Alexander Hamilton, Mr. Mims laid special stress upon the interesting material which the diary contains for Philadelphians.

Moreau de St. Méry spent no less than three years and ten months of his exile in this city, maintaining a bookstore and printing shop at Front and Walnut Streets. He offered for sale in his bookstore a large collection of foreign books which attracted many cultured Philadelphians. At his printing press were published in French, besides other works, three of his own well-known books, "La Danse," "La description de la partie espagnole de St. Dominique" and "La description de la partie française de St. Dominique." Besides, at this same press was published in French from October 15, 1795, to March 14, 1796, a daily newspaper, entitled "Le Courrier de la France et des Colonies," a most unique publication which recorded for the exiles the latest news from France and the West Indies, and served as an organ for the society of Frenchmen who resided then in Philadelphia.

Moreau's shop became in a sense the place of rendezvous for such famous exiles as Talleyrand, Beaumetz, Blacon, de Noailles, Talon, la Rochefoucauld de Liancourt, who had taken refuge "in the ark of Noah," which one of them wittily called Philadelphia at that time. In this connection, the speaker called attention to the very intimate relations existing between Talleyrand and Moreau, stating that the diary contained no less than seventeen unpublished letters from the hand of Talleyrand which were written to Moreau. One passage was quoted from the diary which gave a most striking picture of the famous diplomat, sipping away at a glass of good old Madeira and chatting with his congenial companions, both oblivious of time, until the good wife of Moreau came to drive away the garrulous bishop, reminding him that he might spend his morning lazily in bed, whereas his friend must be up early at the daily duties of his shop. It is interesting to add that Talleyrand, after he had regained power in France, never forgot the friend of his days of exile, but succeeded in reopening the doors of France for his return and providing for his welfare in later life.

In conclusion the speaker expressed confidence that the publication of the diary at the Yale University Press during the coming summer would prove of interest to all students of Philadelphia's history and would add another diary of value to the many interesting records of travel by foreigners in the United States.

The Legendary and Myth-making Process in Histories of the American Revolution: SYDNEY GEORGE FISHER.

Bardaisan and the Odes of Solomon: WILLIAM ROMAIN NEWBOLD.

Sumerian Bookkeeping Five Thousand Years Ago (Illustrated): GEORGE A. BARTON.

The Political Ideals of Ulrich von Hutten: KUNO FRANCKE.

Recent German criticism is inclined to undervalue the services rendered by Ulrich von Hutten to the cause of liberalism. In his personality German humanism finds its most ravishing and irresistible expression. In him the Erasmian enlightenment burns into a revolutionary power. It is a mistake to think of him primarily as an ally of the Lutheran reformation. Hutten would have been the last to submit to the dogmas of the Lutheran church. His aim was the political and intellectual reconstruction of Germany. Abolition of the monasteries, confiscation of church property, secularization of the schools and the higher institutions of learning, safeguarding of free thought and free inquiry, centralization of the empire, limitation of the power of the territorial princes, creation of a powerful public opinion based upon an alliance of the cities and the knighthood—these were his political ideals. If he failed in his efforts to put these ideals into practice, he has at least given a powerful stimulus to the modern conception of the state as the legitimate upholder of liberal culture and spiritual progress.

Some Anthropological Aspects of the Brain with Reference to Race, Sex and Intellect: EDW. ANTHONY SPITZKA.

A discussion of the weight and morphologic appearances of the human brain and its several parts resulting from a series of studies upon specimens of various races and notable individuals, including those of Andamanese, Nicobarese, Chinese, Eskimos, Negroes, as well as eminent scholars from civilized nations. Particular attention is called to the relative redundancy of certain association areas of the cerebral cortex in eminent men and women and also to the relatively larger

callosum, or great commissure associating the hemispheres of the brain. The lecture was illustrated by lantern slides.

Waterway Conservation: LEWIS M. HAUPT.

This paper treats of population as the basis of wealth and points out the enormous increase which must follow in the coming century, if the existing ratio continues, which would give a population of nearly 600,000,000 by 2012 and which will seriously tax our political and social conditions, while it also increases enormously the wealth due to the "unearned increment" and the desire to exploit our natural resources.

The great increase in transportation, which has almost doubled in the last decade, is cited as indicating the inability of the overland carriers to cope with the future demand and the absolute necessity of supplementing the railroads by greatly improved water- and highways is urged as a measure of relief and regulation.

Attention is directed to the efforts to secure conservation by statute laws which have become so intricate that great differences of opinion have arisen as to their interpretation, scope and application and a corresponding paralysis has resulted between state and governmental jurisdiction, thus retarding development and increasing the cost of living.

Violations of natural and physical laws have also resulted in great floods and consequent devastation, as is being forcibly impressed by the trail of disaster along the Ohio and Mississippi rivers at the present time, which have overtopped the levees with a lesser discharge than in former years, due to the closure of the outlets and confining of the sediment to the bed of the streams, by the extension of the levees.

These conditions are the sequences of the centralization of authority and control in the general government over all the waters of the country and the general demand from all sections for national appropriations from the federal treasury, which can not be met, and result in sectional jealousies and political pressure for patronage to the great detriment of local initiative and of open competition by states and localities in immediate need of relief.

The illustrations accompanying the paper showed how the energy of currents might be utilized to create automatic channels and remove bars in rivers and harbors at much less cost both for construction and maintenance than by the current means of dredging or the use of extensive jetties

in pairs, which obstruct the tides and create deposits in the pathway of commerce, thus increasing the cost.

On Thursday evening a celebration of the centenary of the introduction of gas as an illuminant, under the auspices of the American Philosophical Society, the Franklin Institute, the American Chemical Society and the American Gas Institute, was held in the hall of the Franklin Institute, Philadelphia, with President Keen in the chair.

A paper on "By-products in Gas Manufacture," by Charles E. Munroe, was read.

FRIDAY, APRIL 19—MORNING SESSION

President Keen in the chair

Heredity of Feeble-mindedness: HENRY H. GODDARD. Introduced by Dr. Henry H. Donaldson.
The Inheritable Factors of Epilepsy: DAVID F. WEEKS. Introduced by Dr. Henry H. Donaldson.

Is the Control of Embryonic Development a Practical Problem? CHARLES R. STOCKARD. Introduced by Dr. Henry H. Donaldson.

Many deformities occur among animals in nature and a great number of deformed human beings are born. Many other individuals suffer from minor defects in bodily structure. These defects are often internal and may be unknown to their possessor, yet they frequently give rise to disease conditions which sometimes actually result in death. There are, for example, many congenital defects of the heart and other parts of the circulatory system, digestive tract, reproductive organs and developmental arrests may occur in almost all parts of the body.

These conditions must be regarded as a structural disease which causes the death of a number of children before they are born and handicaps many others throughout their lives. The cause of such defects must be ascertained, then a possible means of control may be found.

Observations on human families and experiments on lower animals prove that these conditions are due to one of two causes as the case may be. First, the embryo may have developed in an unfavorable chemical environment; or secondly, the germ cells of one or both parents may have been defective.

When the eggs of lower animals are treated with various poisons during their development they give rise to monstrous individuals. For example, when developing fish's eggs are treated for a short time with alcohol in some cases as many as 98 in 100

of the eggs give rise to fish which show almost all known deformities of the brain, eyes and other parts of the nervous system.

Guinea-pigs have been put into a state of chronic alcoholism and when such animals are mated either together or with normal individuals the resulting offspring are greatly affected. Many are aborted early in development, or reach term and are then born dead. Only a few are born alive and the great majority of these die after a short time, showing many nervous disorders and dying in convulsions.

A normal female when mated with an alcoholic male gives an almost equally poor result. This shows that the paternal germ cells are affected by the alcohol and are thus rendered unable to give a normal combination and abnormal offspring are produced.

Abnormal and deformed individuals may thus be artificially produced at will and the provoking cause is proved to be an unfavorable chemical environment acting on the germ cells of the parent or directly upon the embryo. The proposition of reversing the experiments thus presents itself, and some mode of treatment or control should be devised by which parents may be put into the proper state to produce as nearly as possible a normally vigorous offspring. Enough is known at present to make the control of development possible to a slight degree at least.

An Avian Tumor in its Relation to the Tumor Problem: PEYTON ROUS. Introduced by Dr. Alexander C. Abbott.

The paper reports the results of an experimental investigation into the cause of a malignant tumor. For the work a sarcoma of the chicken has been employed. This growth is transplantable from fowl to fowl, and presents the typical picture of a malignant tumor. It has been studied under many different conditions, not only in the adult fowl, but, by a special technic, in the chick previous to hatching.

Attempts to isolate a cause for the sarcoma have been successful. By filtration, or by drying, there can be separated from the living tumor tissue an agent which will produce the growth in fowls previously healthy. This active agent has not been directly observed, and is in all probability ultramicroscopic, since it will pass through filters which hold back minute bacteria. Its properties identify it as a living organism. In giving rise to a tumor it seems able to act only exceptionally and at points and upon tissues which have been

injured in some way. This dependence on a preliminary tissue derangement explains why the disease is not infectious in the ordinary sense.

The chicken sarcoma, like the tumors in general, can not be transmitted to other species; and the facts with regard to its cause must not be taken as applying directly to the tumors of other creatures. But these facts constitute the first demonstration of the cause of a malignant tumor, and they not unlikely illustrate a general truth.

Protein Poison: Its Preparation and Its Nature:
VICTOR C. VAUGHAN.

It has long been known that the protein molecule contains a poisonous group. This has been demonstrated by the administration of foreign proteins, parenterally, to heterologous animals. It has also been shown that peptones are poisons when injected subcutaneously and intravenously. The writer, together with Dr. Wheeler in 1903, succeeded in splitting up the protein molecule so as to get a highly poisonous body. This has never been obtained in a state of chemical purity, and its exact composition is not known. Its effects upon animals have been closely studied, and it may be prepared from all kinds of proteins, bacterial, vegetable and animal.

Bacterial Vaccines, with Special Reference to Typhoid Prophylaxis: FREDERICK F. RUSSELL.
Introduced by Dr. Alexander C. Abbott.

Alternate Life: ALEXIS CARRELL.

Dynamical Theory of the Globular Clusters and of the Clustering Power Inferred by Herschel from the Observed Figures of Sideral Systems of High Order: T. J. J. SEE. By title.

Some Notes on Persian Mystic Poetry: A. V. WILLIAMS JACKSON.

FRIDAY, APRIL 19—AFTERNOON SESSION

Vice-president William B. Scott in the chair
Exhibition of Volumes of Illustrations of North American Vegetation: JOHN W. HARSHBERGER.
History of the Fungus of the Chestnut-tree Disease: WILLIAM G. FARLOW.

The Classification of the Black Oaks (Illustrated): WILLIAM TRELEASE.

Attention to bud and fruit characters has led to a classification of the black oaks quite different from their usual arrangement according to leaf-form, and five groups of species are recognized, three of the eastern states, one of the southwest and one of the Pacific states. The eastern groups are the black oaks (black jack, turkey oak, Spanish oak and quercitron), scarlet oaks (scarlet oak, gray oak, Hill's oak, red oak, Texas red oak and

bear oak) and swamp oaks, these two sets, the water oaks (water oak, pin oak and Stone Mountain oak) and willow oaks (shingle oak, willow oak, laurel oak, running oak, cinnamon oak and myrtle oak). The southwestern olive oaks (Emory's oak and white-leaf oak) and the Californian holly oaks (evergreen oak, highland oak and Kellogg's oak) are less related to one another and to the eastern black oaks than these are to one another, and appear to have originated independently of these.

The Mammals of the Patagonian Miocene (Illustrated): WILLIAM B. SCOTT.

Illustrations of Remarkable Cambrian Fossils from British Columbia (Illustrated): CHARLES D. WALCOTT.

Dr. Walcott described a very remarkable and ancient fauna that he found in connection with geological explorations in the higher Rocky Mountains of British Columbia. From a camp at 7,000 feet elevation, he climbed a thousand feet to a ledge of rocks where the ancient Cambrian fossils are so perfectly preserved that the internal anatomy of many of the worms and crabs may be reproduced by photography.

His description of the fossils was illustrated by lantern slides made direct from the photographs of specimens representing over fifty genera heretofore unknown. The bay in which the mud was deposited, which now forms the rocks containing the fossils, was connected with the open ocean, and at the spot where the fossils were found the waters must have swarmed with the invertebrate life of the time. No fishes or other vertebrates were found to have existed at this ancient epoch. The earliest vertebrate remains known are several thousand feet higher up in the strata, and are many thousands of years younger than the Burgess shale fossils.

The marine worms are so perfectly preserved that they show not only the exterior form, but the interior intestine and the long proboscis which the worms thrust out through the mouth to secure food and to aid in drawing themselves through the mud.

The crabs show the intestinal canal, liver and a beautiful series of legs, gills and claws connected with the appendages about the mouth.

Specimens of *Medusæ*, or jelly fish, are beautifully preserved, even to the details of the thread-like swimming muscles. Dr. Walcott also showed upon the screen illustrations of the sponges, and many other rare forms of life.

Some Considerations Bearing upon the Origin of Lava (Illustrated): WILLIAM H. HOBBS.

The ideas which are generally held concerning the origin of lava have all gone out from the idea of a liquid interior to the earth. It has, however, been shown in recent years that the earth can not have a fluid interior, but on the other hand must be as rigid as a ball of glass of the same size. Within the earth the temperatures of the rock would easily melt it under surface conditions, but the pressure from the super-incumbent load elevates the point of fusion and so keeps the rock rigid, or as we might say "solid," though realizing that the condition may in many respects be quite unlike that of bodies at the surface of the earth. There must, however, be local and probably temporary reservoirs which supply the lava which exudes or is rejected from volcanoes. It is shown in the paper that the position of active volcanoes, particularly about the Pacific, suggests that the lava reservoirs which supply their lava have been due to local reliefs from pressure beneath arches of strong formations developed in the process of mountain making. The relative strengths of different sedimentary formations lead inevitably to the conclusion that the type of formation which thus fuses and produces lava, is what is known as shale or slate. Studies of the chemical composition of igneous rocks, which compositions are limited in range, support this view; and the study of the gases which lavas give off affords some further striking confirmations of the theory.

Recent Archeological Discoveries in Peru (Illustrated): HIRAM BINGHAM. Introduced by Mr. Henry G. Bryant.

The Discovery of the Continent of Antarctica by Americans—An Historical Vindication: General ADOLPHUS W. GREELY.

The speaker spoke of the unfamiliarity of the people of the United States with early American explorations of the South-polar regions, historical importance of vindicating America's title to the earliest discovery of the Antarctic continent, and to the first explorations that discovered and recognized its continental extent; discovery in 1821 of the northernmost lands of Antarctica, by Captain N. B. Palmer, a Connecticut sealer. Palmer Land was charted by George Powell with South Shetlands in 1822, and recognized by France in 1824. A voyage in 1831 of Master (retired) John Biscoe, R.N., was referred to, whereby Palmer Land was replaced on

British charts by Graham Land, named after the first lord of the admiralty. Palmer Land, ignored in the British Antarctic Manual, 1901, is recognized by only two lines in the Americanized Encyclopedia Britannica, 1911, which gives a column to Biscoe and Graham Land.

Emphasis was laid on Wilkes's discovery of extended and widely separated lands in 1840, with their recognition as forming the Antarctic continent, ignored by Capt. J. C. Ross in 1843, discredited by Encyclopedia Britannica in 1875, and declared non-existent by Capt. R. E. Scott, R.N., in 1905. Meanwhile Sir Clements Markham claimed in 1889 the honor of discovering the continent for Ross. British Antarctic Manual, 1901, admits the existence of one point (Knox Land). Mill in 1911 Encyclopedia Britannica admits in general that Wilkes's discoveries are to be indefinitely accepted. Occupation in 1912 by Mawson's Australian expedition of Adelie Land and Termination Land, vindicates Wilkes. Importance of incorporating these facts in appropriate American text-books was urged as a patriotic and educative duty.

The Interrelations of Eight Fundamental Properties of Classes of Functions: ARTHUR D. PITCHER. Introduced by Professor Eliakim H. Moore.

On Friday evening Professor R. W. Wood, of Johns Hopkins University, delivered a lecture before the society and guests at the College of Physicians on "The Study of Nature by Invisible Light, with Especial Reference to Astronomy and Physics."

The lecture was followed by an informal reception.

On Saturday morning at 9:30 o'clock an executive session was held in the hall of the society at which candidates for membership were balloted for. As a result of the election the following new members were announced: Albert T. Clay, B.A., Ph.D., New Haven; George W. Crile, M.D., Ph.D., Cleveland; Arthur Louis Day, Ph.D., Washington; Edward Curtis Franklin, Ph.D., Washington; John Grier Hibben, Ph.D., LL.D., Princeton; G. Carl Huber, M.D., Ann Arbor; James Furman Kemp, ScD., New York; Arthur Henry Lea, B.A., Philadelphia; John Matthews Manly, Ph.D., Chicago; Edward Bennett Rosa, ScD., Ph.D., Washington; Frank Schlesinger, M.A., Ph.D., Allegheny, Pa.; George E. de Schweinitz, M.D., Philadelphia; Frederick Winslow Taylor, M.E., Philadelphia; Roland Thaxter, A.M., Ph.D., Cambridge, Mass.;

Oswald Veblen, Princeton; George Friedrich Julius Arthur Auwers, Ph.D., Berlin; Wilhelm Ostwald, Sc.D., LL.D., Leipzig; Magnus Gustaf Retzius, Stockholm.

SATURDAY, APRIL 20—MORNING SESSION

President Keen in the chair

Some Geochemical Statistics: FRANK W. CLARKE.

The author first discussed the average composition of the igneous rocks, and then compared them with rocks of sedimentary origin. From the amount of soda lost by the decomposition of the igneous rocks, and the amounts retained by the sedimentaries or leached into the ocean, he showed that about 78,000,000 cubic miles of the primitive crust of the earth had been decomposed, forming a mass of rock consisting of about 80 per cent. shales, 15 per cent. sandstones and 5 per cent. limestones. He next compared the rate at which river waters transport dissolved salts to the ocean, with the composition of the ocean itself, and from these data computed the probable age of the earth since the continents assumed their present form at something near 83,000,000 years. The saline matter of the ocean alone amounts to about 5,000,000 cubic miles, or enough to cover the entire surface of the United States with a solid mass a mile and three quarters thick. The rate at which sediments are being deposited in the ocean was also determined, and found to be about 0.000027 inch annually.

Some General Results of the Work of a Century on the Atomic Weights of the Chemical Elements: GUSTAVUS D. HINRICHS.

Absorption Spectra and the Solvate Theory of Solution (Illustrated): HARRY C. JONES.

A large number of lines of evidence have been brought to light in the laboratory of the author, all pointing to the conclusion that a dissolved substance combines with more or less of the solvent in which it dissolves, about 7,000 solutions have now been studied with respect to their power to absorb light. It has been found that a given colored compound dissolved in different colorless solvents absorbs light very differently in the different solvents. This is interpreted as being due to a combination of the different solvents with the dissolved substance, forming the different compounds which absorb light differently. The bearing of this work on the nature of solution is important, and solution is the most important condition known to man from the standpoint of natural science in general.

Matter in the pure homogeneous condition does not enter into chemical reaction. It becomes active chemically only when dissolved. Chemistry, biology and geology owe their existence to matter in the dissolved state, and any light thrown on the nature of solution is of importance for the natural sciences in general.

The theory of solution hitherto held has been found to be insufficient, not applying to the very solutions that give us natural science.

In dealing with solutions we must always take into account the part of the solvent combined with the dissolved substance.

The Classification of Carbon Compounds: MARSTON T. BOGEET.

The subject is considered primarily from the standpoint of classification for purposes of instruction in organic chemistry. The various ways in which carbon compounds have been classified from time to time are traced historically, from the earliest period to the present, and the author expresses himself in favor at the present day of a classification based on chemical structure, grouping together all compounds of essentially similar function. Thus, all hydrocarbons, saturated and unsaturated, acyclic and cyclic, should be considered together, all simple halogen derivatives, and so forth. The author has used this method with his students at Columbia University for the past ten years and has found it very satisfactory.

An Autocollimating Mounting for a Concave Grating (Illustrated): HORACE CLARK RICHARDS.
Thermal Relations of Solutions: WILLIAM F. MAGIE.

The heat capacity of electrolytes dissolved in water is related to the temperature change of the heat of dilution. Experiments to demonstrate this were described and it was pointed out that the heat of dilution is a difference between two quantities of heat—one evolved in an amount proportional to the absolute temperature—the other absorbed in an amount independent of the temperature. One of these quantities is proportional to the dissociation which occurs on dilution and measures the energy lost by the solute as its ions combine with water. The other involves as a part of its value the heat absorbed by the dissociation.

A formula for the relations of the osmotic pressure to the temperature was proposed, from which the heat of dilution can be deduced. It was shown for solutions of common salt that the constants of this equation can be calculated from the freezing points and the boiling points of the solution, and

that they lead to the observed values of the heat of dilution.

The special significance of these relations lies in the strong support which they give to the theory that the molecules and ions of a salt in solution are associated or combined with the molecules of water.

The Measurement of Temperature up to 1750° C. (Illustrated): ARTHUR L. DAY. Introduced by Professor William F. Magie.

The gas thermometer is the standard thermometer in terms of which all temperatures are defined.

The gas thermometer problem at the present stage of its development has become primarily a problem for experimental study with two definite purposes, one to increase the accuracy of the measurements, the other to increase their range. The range through which temperatures can now be determined in terms of the fundamental definition (the expansion of gas under constant volume or pressure) has now reached nearly to the absolute zero downward, and to 1550° C. upward. The present investigation is concerned with the higher temperatures lying between 300° and 1550°. The accuracy attained in the present investigation within this region is about 0.2° in the vicinity of 300° and 2° at 1550°.

For the purpose of establishing temperatures of reference in this region for general use, the following constants have been determined:

Cadmium (melting point)	320.8 ± 0.1
Zinc (melting point)	419.3 ± 0.1
Sulphur (boiling point)	444.5 ± 0.1
Antimony (melting point)	629.8 ± 0.2
Silver (melting point)	960.0 ± 0.7
Gold (melting point)	1062.4 ± 0.8
Copper (melting point)	1082.6 ± 0.8
Li ₂ SiO ₃ (melting point)	1201.0 ± 1.0
Nickel (melting point)	1452.3 ± 2.0
Palladium (melting point)	1549.2 ± 2.0
Platinum (melting point)	1752.0 ± 5.0

Selective Scattering Reflection and Absorption by Resonating Gas Molecules (Illustrated): ROBERT WILLIAMS WOOD.

Some Observations on the Transmission of Sound through Walls: ARTHUR GORDON WEBSTER.

New Magnetic Charts of the Indian Ocean (Illustrated): LOUIS A. BAUER.

The charts exhibited embody the results of magnetic observations made during the summer and fall of 1911 on board the non-magnetic yacht *Carnegie* operating under the direction of Dr. L.

A. Bauer, director of the department of terrestrial magnetism of the Carnegie Institution of Washington.

The necessity of the new charts arose from the exceptionally large errors found in the magnetic charts at present in use by mariners. Thus, for example, the errors in the charted compass directions for two of the most recent charts approximate respectively four degrees and six degrees, though one of the charts was issued as recently as 1910. With the exception of a few values found by the vessel used in the Pacific Ocean work, namely, the *Galilee*, these are the largest errors thus far revealed. In the portions of the Atlantic Ocean covered by the *Carnegie* the compass chart errors have generally been below two degrees, though running at times up to two and a half degrees.

The chart errors in the compass directions are usually found to be systematic, that is, in the same direction for large stretches, and are to be ascribed largely to erroneous secular changes allowed for in attempting to bring previously observed values up to date.

Thus, for example, by comparing the *Carnegie* values of 1911 with those obtained on board the German Antarctic vessel, the *Gauss*, in 1903, it is found that the north end of the compass moved to the eastward (hence diminished west declination) at the average rate of about 11' per year off the southeast end of Africa, whereas in the vicinity of the islands of St. Paul and New Amsterdam in the Indian Ocean (lat. 35° 16' S., long. 74° 46' E.) it moved to the westward (increased west declination) at the average rate of about 13' per year. The charts give secular changes of only about one fourth of these amounts, so that the error of reduction in but ten years amounts almost to 2°. It is doubtless due to these large secular changes disclosed in the Indian Ocean, and especially their rapid variation with geographic position, that the large errors mentioned have crept into the charts.

The errors in the other magnetic elements, while of less importance to the mariner, are of consequence to theoretical investigations regarding the earth's magnetism. In the magnetic dip, the errors on the present cruise have amounted at times to 4°, and in the horizontal intensity to about one twentieth part. While some of the results derived from previous analyses of the earth's magnetic field have pointed to the possibility of large and more or less systematic chart errors, it was not suspected that they would reach

the magnitude disclosed by the work of the *Galilee* and of the *Carnegie*.

The *Carnegie* is at present making a circumnavigation cruise and is expected back in New York towards the end of 1913, having left the same port in June, 1910. Up to February 1, 1912, this vessel has already covered about fifty thousand miles. She left Manila on March 23, in command of W. J. Peters, bound for the Fiji Islands.

Owing to the non-magnetic construction of the *Carnegie* and the absence in consequence of any deviation corrections, it is possible to obtain and communicate results expeditiously. The data are promptly transmitted to the chief hydrographic establishments issuing magnetic charts in order to enable them to make the necessary corrections from time to time.

SATURDAY, APRIL 20—AFTERNOON SESSION

Vice-president Edward C. Pickering in the chair
Symposium on Stellar Spectroscopy—Radial Velocity (Illustrated): WILLIAM W. CAMPBELL.

Our knowledge of motions of the planets around the sun and of the satellites around the planets has been reduced to a system, of remarkable accuracy. Knowledge concerning the motions of the stars is growing rapidly: shall we be able to develop this knowledge into a system?

Stellar motions are studied through their components known as *proper motions* and *radial velocities*. Proper motion studies of the stars have been fruitful, but limited in value by our ignorance of stellar distances. Radial velocities have the advantage that they are independent of stellar distances.

All observed stellar motions contain components due to the motions of the observer. The first step in studies of stellar motions is to determine the elements of the solar motion and to eliminate its effects from the observed motions of the stars, thus leaving the motions with reference to the stellar system.

The direction of the solar motion has long been fairly well known: the solar system is approaching a point 10° or 15° southwest of *Vega*. The speed determined from 1,200 radial velocities is $19\frac{1}{2}$ kilometers (12 miles) per second.

The velocities of the stars are functions of their spectral classes; *i. e.*, of their effective ages. The young stars are traveling slowly—12 kilometers per second, on the average; the middle-aged stars more rapidly— $28 \pm$ km. per second; and the old stars the most rapidly— $34 \pm$ km. per second. Our sun,

as a middle-aged star, is traveling with a speed, $19\frac{1}{2}$ km. per second, far below the average of its class. We do not know why stars increase their speeds as they grow older.

Amongst the brighter and nearer stars those resembling our sun in effective age predominate; and they partake somewhat of the solar motion. Neglecting these brighter middle-aged stars, the remaining stars form a fairly homogeneous mixture of stars of all ages.

Radial velocity data increase our estimate of the scale of the universe about 50 per cent. above proper motion estimates.

Observers with great telescopes have found that one star in eighteen, down to the 9th magnitude, is a double star, and that one in eleven or twelve brighter than the 5th magnitude is double. The spectrograph has shown that at least one star in four, down to the 5th magnitude, is a double star; with components so close together that they have never been seen separately in our most powerful telescopes. For young stars the observed proportion is greatest, the components are closer together, and the orbits are rounder. For the old stars the proportion of observed doubles is smallest, the orbits are larger and more elongated. The proportion of discovered doubles, especially amongst the old stars, is rapidly increasing. Conclusion: Double stars have been joined and developed from parent gaseous masses, substantially as mathematical astronomers had predicted. There is the utmost need for cooperation amongst astronomers in observing the radial velocities of stars between the fifth and seventh magnitudes.

Objective Prism Spectra: EDWARD C. PICKERING.
On the Prospect of Obtaining Radial Velocities by Means of the Objective Prism: FRANK SCHLESINGER.

Relations between the Spectra and other Characteristics of the Stars (Illustrated): HENRY N. RUSSELL.

Among the stars whose distances can be measured with some approach to accuracy, and whose real brightness can thus be determined, there exists, with few exceptions, a very marked relation between the actual brightness and the class of spectrum. The stars of spectrum A (resembling Sirius) are on the average about 50 times as bright as the sun; those of spectrum F5 (like Procyon) about five times as bright as the sun; those with spectra like the sun's (class G) are nearly equal to the sun in brightness; while the orange stars of spectrum K average only one sixth as bright, and

the red stars of classes K5 and M are usually less than one fiftieth as bright as the sun. On the average, the stars of each spectral class are seven times as bright as those of the following class. This rule holds true both for the stars relatively near us, whose individual distances can be measured, and for those belonging to clusters whose distances are known.

There exist, however, many stars of great brightness, of all spectral types, which are almost all so remote that their distances can not be accurately measured. From the best available data, these stars appear to be on the average from 100 to 250 times as bright as the sun, without much difference between the different spectral types.

Among the stars redder than the sun, these two groups, of different brightness, are widely separated; but among the whiter stars they run together, and become identical for the whitest stars (class B), which average more than 250 times as bright as the sun.

In the cluster of the Pleiades (whose distance has so far been unknown) all spectral classes from B5 to G are represented, and the relative brightness of the different types follows very closely the law which holds good for the fainter stars already mentioned. If it is assumed that the stars of the Pleiades also follow the same law as regards their actual brightness, the distance of the cluster is found to be such that their light takes 600 years to reach us.

From a study of double stars it is found that the stars of the brighter class do not greatly exceed those of the fainter class in mass, and hence that they are either much less dense, or much brighter per unit of surface, or both. The average density of the stars of classes B and A can be found with the aid of certain stars which eclipse one another, and it follows that these stars give off much more light per square mile of surface than the sun does. It can also be shown that the faint red stars give out much less light per square mile than the sun.

If the same is true of the other kind of red stars (which several lines of argument make very probable) these stars must be of enormous size, but very low density.

An arrangement of all these groups of stars in order of increasing density would begin with the bright red stars of the type of Antares, run up the series of stars of great brightness to those of spectrum B, and then down the series of fainter stars, past those like the sun, to the faintest and

reddest stars. It seems probable that this arrangement represents the evolutionary history of a star, which at first becomes heated more and more by its own contraction, and finally, as it becomes too dense to admit of further shrinkage, cools off like a solid body.

At the annual dinner on Saturday evening at the Bellevue-Stratford nearly eighty members and guests were present, the toasts being responded to as follows:

"The Memory of Franklin," by Professor John Bassett Moore.

"Our Sister Societies," by Professor Chas. F. Chandler.

"Our Universities," by Professor Ernest W. Brown.

"The American Philosophical Society," by Professor Francis B. Gummere.

An important feature of this occasion was the presentation of the Henry M. Phillips prize of two thousand dollars to the author of the crowned essay on "The Treaty-making Power of the United States and the Methods of its Enforcement as Affecting the Police Powers of the United States." The successful competitor was Charles H. Burr, Esq., of Philadelphia, the judges of award being Joseph Choate, former ambassador to Great Britain; Judge John C. Gray, of Harvard College; Henry Wade Rogers, dean of the Yale Law School; J. M. Dickinson, former Secretary of War; and Joseph Brown Scott, of the Department of State at Washington.

In their sealed verdict the judges declared that they found great difficulty in deciding the essay of Mr. Burr and that of Edward S. Corwin, of Princeton University.

ARTHUR WILLIS GOODSPEED

SOCIETIES AND ACADEMIES

THE TENNESSEE ACADEMY OF SCIENCE

ON March 9, 1912, a meeting was held in Nashville, Tennessee, to make plans and prepare a constitution for a Tennessee Academy of Science. The meeting was called by Dr. Geo. H. Ashley, then state geologist.

The first general meeting, which was largely attended, was held at the Carnegie Library, Nashville, on April 6, at which time the following officers were elected: C. H. Gordon, president; J. I. D. Hinds, vice-president; Wilbur A. Nelson, secretary, Capitol Annex, Nashville; S. M. Barton, treasurer, and E. S. Reynolds, editor; after which the following papers were read:

"On the Reported Discovery of Radium in Arkansas," A. H. Purdue, former state geologist of Arkansas.

"Neon and Wireless Waves," William L. Dudley, Vanderbilt University.

"Rock Striations and their Causes," Chas. H. Gordon, University of Tennessee.

"Railroad and Road-building in Tennessee before Civil War," Gus Dyer, Vanderbilt University.

"The Beginning of Music," R. M. Ogden, University of Tennessee.

"Food and Drug Inspection in Tennessee," Lucius P. Brown, Tennessee Food and Drug Inspection.

"Review of 'History of Geological Work in Tennessee,'" L. C. Glenn, Vanderbilt University.

"Some Remarkable Phenomena of the Tornado in Montgomery County, Tennessee, April 29, 1909," James A. Lyon, S. P. University.

"Some Effects of Parasitic Fungi on Leaf Tissue," Ernest S. Reynolds, University of Tennessee.

"Photomicrography in Colors by the Lumière Process" (illustrated); "An Apparatus for Washing Fixed Microscopic Material" (illustrated), Samuel M. Bain, University of Tennessee.

"The Selection of Food in Unicellular Animals" (illustrated), Asa A. Schaeffer, University of Tennessee.

"Electrical Conductivity in Dental Fillings," John Daniels, Vanderbilt University.

WILBUR A. NELSON,
Secretary

THE ACADEMY OF SCIENCE OF ST. LOUIS

THE meeting of the academy was held at the academy building on Monday, April 1, 1912, at 8 P.M., President Engler in the chair.

Dr. G. O. James, of Washington University, addressed the academy on "The Application of the Relativity of Gravitation to the Motion of the Perihelion of Mercury."

J. L. Van Ornum, professor of civil engineering at Washington University, reviewed the methods practically applicable to prevent dampness in rubble masonry foundation walls; that is, by drainage or by an impervious coating of their exterior, or by both. Impermeability may be attained by constructing an impervious diaphragm of a bituminous material; by an efficient surface coating, preferably on the outside; by carefully securing a maximum density by properly proportioning the components of the concrete; or by mixing with the concrete certain colloidal (or

other) substances to secure this result. The latter two methods have been experimentally investigated in successive years as thesis work by H. F. McFarland, P. C. Grace, S. Johnson and W. K. Bege-man. Their results agree in general with those of others in concluding that, for any usual conditions, the patented mixtures sold for this purpose vary in effectiveness from very poor to very good; and that proper proportioning of the constituents of the concrete to attain a maximum density, such as is desirable to secure a maximum strength, will also effect practical impermeability; but they differ from the conclusions of some others in the fact that they found no advantage to result from the incorporation of such a material as hydrated lime in the richer mixtures.

The apparatus designed by the students for these experiments, which gave pressure up to forty pounds per square inch, was planned to eliminate certain features of the experimental devices of others which seemed objectionable to them; particularly in eliminating tensile stresses from the specimens tested, with the resulting tendency to form cracks.

Professor Nipher gave a preliminary discussion of a phenomenon observed by Planté. It is the buckling of a fine wire through which an electric discharge is passed. Professor Nipher finds that a long and very fine fuse-wire of lead, lying on a strip of glass, usually breaks at the positive end, at a point where it is made fast by sealing wax. The wire at the same time is urged towards the negative terminal, as positive ions are in a gap of air. The metal wire behaves like the positive column in discharge through gases. The negative end of the wire appears to be urged in the opposite direction, as is also the case at the negative terminal in discharge through gases. It sometimes happens that the wire breaks down at the negative end. Nearly all of the wire, however, appears to have the property of the positive column. It is urged longitudinally in a direction opposite to that in which the negative corpuscles are being conducted. Fine copper wire is now being used, and the ends of the wire are left free to move, while the wire is sealed to the glass strip at various intermediate points. The conditions which determine the limiting point between portions of the wire which are being urged in opposite directions have not yet been fully ascertained. The positive ions which constitute the copper wire are not quite as free to "wander" as they are in the case of solutions, or in discharge through gases.

Present indications are that practically all of the fine wire is being urged in a direction opposite to that of the corpuscular flow. There must, however, be an end effect at the negative terminal of the wire which urges the wire in the opposite direction.

At the meeting of the academy held Monday evening, April 15, 1912, Professor A. S. Langsdorf, of Washington University, addressed the Academy on "Transient Electrical Phenomena," Dr. Chas. H. Turner gave an illustrated account of "Results of Recent Experiments on the Homing of Ants," Dr. Arthur E. Bostwick read a paper on "Atomic Theories of Energy" and Professor Wm. H. Roever, of Washington University, exhibited and explained "A Mechanism for Illustrating Lines of Force."

GEORGE T. MOORE,
Corresponding Secretary

THE TORREY BOTANICAL CLUB

THE meeting of January 31 was held in the Museum Building of the New York Botanical Garden, Vice-president Barnhart presiding. Twenty-five persons were present. The minutes of the meetings of November 29, 1911, and January 9, 1912, were read and approved. Dr. Marshall A. Howe, chairman of the auditing committee, reported that the committee had examined the books of the treasurer and found them to be correct. The report of the budget committee was presented and approved.

The announced scientific program consisted of the reading of papers on "Sir Joseph Dalton Hooker: His Life and Works," by Dr. N. L. Britton and Dr. J. H. Barnhart. Dr. Britton's paper related chiefly to the life of this distinguished botanist, and his publications relating to botany were discussed by Dr. Barnhart. As Sir Joseph Hooker was an honorary member of the Torrey Club, Dr. Barnhart took this occasion to bring before the club the constitutional provisions relating to honorary membership and read the list of all persons who have been elected to honorary membership.

Mr. Fred J. Seaver spoke briefly on the viability of the spores in *Pyronema*. While *Pyronema* has been made the subject of numerous research papers and is figured and treated in most of the recent text-books of general botany, it still remains an unknown plant to most botanists, except to the few who have done critical work with it. There is

no reason for it being so, for the fungus is fairly common and is easily grown, as has already been shown in previously published papers. In a recent experiment the speaker was able to show that the spores of this fungus which had been kept nearly three years in the herbarium germinated readily in hanging-drop culture. This last point should be of general interest to teachers of botany, since it means that the plant can be grown and studied from living material and the old plants then placed in an envelope and kept until the next year, when they can be planted and grown again. No complicated technique is necessary for the growing of *Pyronema*. A pot of garden soil should be heated. Heating can be carried on in an autoclave or sterilizing oven. If these are not to be had bake in an ordinary oven. Saturate the soil with tap water after heating and plant the spores. Growth of mycelium should be abundant in two or three days, sex organs should appear in about a week, and mature ascocarps a few days later. A more detailed account of this subject will appear in the *Bulletin* of the club.

Dr. Marshall A. Howe spoke briefly on "Some Marine Algae from the Stomach of a Peruvian Green Turtle" and exhibited specimens from the source indicated, collected in Peru by Dr. Robert E. Coker. The fragments were in a good state of preservation and two of the species concerned are readily determinable, the most abundant being *Rhodyminia flabellifolia*, a common Peruvian and Chilean species and a close relative of the edible "dulse." The alga coming next in point of abundance is *Caulerpa flagelliform lingulata*, a species occurring elsewhere in Dr. Coker's Peruvian collections, but not before reported from the shores of the American continent. Fragments of a species of *Gelidium* not so certainly determinable also occur.

Dr. W. A. Murrill gave a short account of the progress of his studies on the Agaricaceæ of tropical North America and also read some mycological notes relating to the Washington meeting.

THE meeting of February 13 was held at the American Museum of Natural History at 8:15 P.M. Twenty-three persons were present.

The announced scientific program consisted of a lecture on "Some Botanical Features of a Desert Mountain Range," by Dr. Forrest Shreve. The lecture was illustrated with lantern slides.

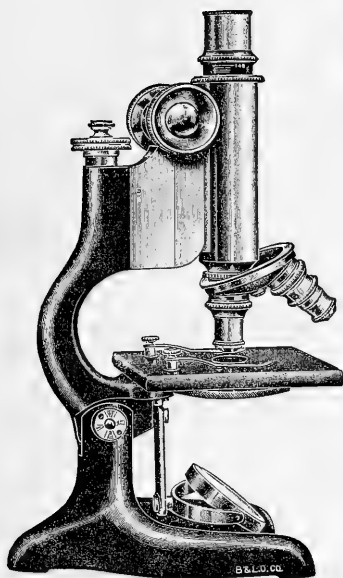
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SCIENCE

FRIDAY, MAY 24, 1912

UNIVERSITY CONTROL¹

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Bologna and Paris are the archetypal universities from which all others have descended and from which they have in some measure inherited their present organization and methods. In the first decades of the twelfth century Irnerius lectured at Bologna on the civil law, and Abelard at Paris on philosophy and theology. There were at the same time other eminent teachers in those cities, and students were attracted from all parts of Europe. The students in a foreign city organized themselves into guilds for mutual protection and assistance in accordance with the custom of the time. These were the first universities. The lecturers, who had previously taught as the sophists at Athens and the rhetoricians at Rome, or as masters of music, dancing and gymnastics teach to-day, also organized themselves into societies or universities. There were no endowments; no academic buildings. The professors lectured at their homes or in

¹This paper, more especially the collection of letters from university professors, was prepared for the faculties of the University of Illinois, and for discussion before their committee charged with drawing up a constitution for the university. Papers on the subject have also been presented before the Society of Sigma Xi of the University of Indiana, the Huxley Club of the Johns Hopkins University and at a joint meeting of the faculties of Lehigh University and Lafayette College. The fact that in the last two cases the presentation was in the form of an after-dinner address may account for the more frivolous and rhetorical passages, and for the use of the first personal pronoun. These might have been eliminated—they have been reduced—but a reformer should be concerned with accomplishing his ends rather than with conserving his dignity.

hired houses; the academic convocations were held in churches or monasteries. When there were difficulties with the city authorities or with their colleagues, a group of professors or students might migrate and found a new studium elsewhere. Thus in the thirteenth century offshoots from Bologna gave rise to studia at Reggio, Vicenza, Arezzo, Padua, Vercelli and Siena. Oxford, the third of the great medieval universities, was probably due to a migration from Paris in 1167.

At Bologna the universities of students—who were men of maturity from all parts of Europe, as many as ten thousand at the end of the twelfth century, it is said—obtained control, lording it over the professors by means of the boycott. At Paris the students, organized into nations, were somewhat younger, and the professors, doctors or masters, as they were indifferently named, were in control. In one respect the conditions were curiously similar to the contemporary American university, for there was a college of arts of younger students, and professional schools of theology, law and medicine. We even read of an anticipation of present tendencies in that students had to receive the degree in arts before entering the medical school. About the middle of the thirteenth century there were established colleges of residence which were endowed as eleemosynary institutions for poor students, usually under the control of the church. In England the colleges were the property of the head and fellows, who had complete control of the establishment; on the continent they were somewhat less independent. In the course of time the differences became emphasized. The continental colleges became absorbed in the university and disappeared as halls of residence, whereas at Oxford and Cambridge the colleges practically constituted the university.

It is truly remarkable that there should have been some seventy-five universities throughout Europe before the time of the invention of the printing press and amid the incessant warfare of those days. One may wonder whether love of learning was not greater, intellectual curiosity keener, then than now. The students, numbered by the thousand—legend puts it as high as 30,000—flocked to a university attracted by the reputation of a great teacher. The rich came with their retinues, while the poor begged their way. Irnerius at Bologna, Roscellinus and Abelard at Paris, Grossetête and Roger Bacon at Oxford, were followed by long lines of great men, teachers, scholars, founders of science.

My main concern with the medieval university is that it was extraordinarily unhierarchical, democratic, anarchic, in its organization. The university was then, as it now should be, the professors and the students. The professors, of course, had complete control of the conditions under which degrees were given and in the selection of their colleagues and successors. The doctor earned the *jus ubique docendi*; he was not employed or dismissed. There was an elected council and rectors were elected for a year or for some other short period. Only later there came to be a single rector for the entire studium. The whole paraphernalia of the modern university—endowments, buildings and grounds, trustees and president, heads of departments and deans, curricula, grades and examinations—were absent or subordinated. There were indeed all sorts of routine, customs and limitations, but the university, in an age of feudalism and of absolutism of state and church, attained a remarkable freedom, and its great performance was in large measure due to this freedom.

It further seems to be the case that the waning of the influence of the university

in the course of time was largely due to the loss of freedom. As the universities obtained endowments and buildings, as their governing bodies became organized, they lost their spontaneity and creative leadership. The great philosophers, scholars and men of science of the seventeenth and eighteenth centuries worked in large measure outside the universities. Bacon, Hobbes, Locke and Berkeley; Descartes, Spinoza and Leibnitz; Harvey, Huygens and Laplace; Linnæus, Buffon, Lamarck and Cuvier; Lavoisier, Priestley and Dalton, were not university professors or not primarily such. Newton was, but he relinquished his chair at Cambridge to take a position in the mint at London. The men of science of the seventeenth and eighteenth centuries worked largely in connection with the academies of science, which were then established, and in the newly founded museums, observatories and botanical gardens. This movement is analogous to the contemporary establishment of research institutions outside the universities. There was too much dogmatism, formalism, discipline, routine, control, machinery—it might have been called efficiency if they had had the word in those days—in the university, and scientific men found greater freedom and stimulus in the academies, which, though under the patronage of the court, they themselves controlled.

Toward the close of the eighteenth century the universities throughout Europe had sunk to a low level. Within a period of a few years as many as thirteen German universities became extinct—Mainz, Cologne, Bamberg, Dillingham, Duisberg, Rinteln, Helmstedt, Salzburg, Erfurt, Altdorf, Frankfort, Ingolstadt and Wittenberg. But the new era of freedom and democracy, represented and caricatured by the French revolution, gave fresh life to the universities. The centralized scheme

of Napoleon aggrandized Paris at the cost of the provincial universities, which only just now are regaining their autonomy. In Germany the modern university attained its fruition. The University of Berlin, established in 1809, when the political fortunes of Prussia were at low ebb, played a great part in the regeneration of the nation. It was partly founded on the basis of the existing Academy of Science, as was the University of Munich a little later. It is possible that our newer research institutions, if placed under the control of men of science, may become the freer universities of the future.

During the nineteenth century the German universities rivaled in their influence those of the medieval period. The advances of democracy and of science have been the great achievements of our era. In the advancement of science and to a certain extent in the maintenance of a democracy of scholarship, the German universities have been dominant forces. In Germany the university is indeed the creature of the state and subject to it. But during the nineteenth century academic freedom and the independence and influence of the professor attained a remarkable supremacy. Any student who showed ability could become a *Privatdocent*; if he continued to advance his subject with sufficient distinction and did not starve to death in the meanwhile he became a professor. The professorship has been maintained as a position of dignity, honor and freedom. The professor receives his appointment by the decision of his peers and holds it for life. He may lecture about as much or as little as he likes, on almost any subject, well or poorly as the case may be, with complete freedom in the expression of his views; he is but little concerned with grades, absences, discipline, routine reports, committee meetings and the like; he gives

much or little attention to his students as he may choose. The rector is elected annually by the professors. The curator, the representative of the government, the efficient man who runs things, is nowhere regarded as the intellectual or social equal of the professors.

All this might be supposed to lead to abuses; but the result is there to be seen by every one—the great scholars and men of science; the contribution to national progress and the civilization of the world. No efficient machine driven by the president of an American university can grind out such flour. I fear that the German university can not continue its great performance of the nineteenth century. This was doubtless more the result than the cause of the idealism of the people, now threatened with submergence under wealth and luxury. The modern German university must have its fine buildings, must grow greatly in size. This is inevitable, perhaps desirable. Laboratories, libraries and collections are required on a scale not formerly imagined; there is danger, perhaps need, of more administrative machinery, and the more machinery you have, the more you must get. It seems that the professors now tend to form a bureaucratic guild, too greatly concerned with their own financial status, and too little with the welfare of the docents and associate professors, of the students and of the people. The Prussian ministry is interfering more than formerly in the selection of professors and the management of things. The German emperor, it is said, wants presidents in the American style—we could spare him at least one for each of the twenty-one German universities.

It seems remarkable that in the bureaucratic little states which have since become the German empire, the universities should have been centers of liberal scholarship and free personalities. But it is perhaps gen-

erally the case that the finest exhibitions of the love of liberty and honor are made under persecution or where there are contrasted conditions. It is really quite difficult and discouraging to play the part of an academic hero or martyr now-a-days. One can do it better in Russia than in the United States. Thus a hundred professors at Moscow have recently resigned owing to some interference of the government with the liberty of the professors. In that country students and professors strike, and the government institutes lockouts. They take their liberties seriously, and the professors maintain their right to choose their colleagues and their deans and rectors.

The historic English universities, Oxford and Cambridge, have been primarily groups of independent colleges. The master and fellows are the college; they own the buildings and endowment and divide the income among themselves. They elect their colleagues and successors and of course their head. The headship is an honorary and social position with but few executive powers or duties. Government is by town meeting and committee. There have been abuses of the monastic system, and perhaps even now too much time is spent on details of management. But high standards of scholarship and conduct have on the whole been maintained. From among their resident fellows and from their students great men have been forthcoming in every line of activity. Probably half the leaders of England in statesmanship, scholarship, science, poetry, have come from its two universities, having together no more students than one of our larger institutions; and England has produced more great men than any other nation.

The universities of Oxford and Cambridge, as distinguished from their colleges, have long had a few endowed professorships and conducted libraries, but until

recently they were essentially degree-conferring institutions. They are administered by councils elected by the resident teachers, but the ultimate control is vested, as is becoming, in the masters of arts. The Church of England clergy have perhaps had more influence than is desirable, but their interference has in the main been confined to prescribing the conditions for the degree. In any case it is only a temporary phase, and a certain amount of conservatism is not so bad for a university. It would seem quite absurd to invest the ultimate control of Oxford and Cambridge in a self-perpetuating board, consisting of a score or larger crowd of business and professional men. The chancellorship is an honorary office, without executive power or influence, to which a non-resident graduate of distinction is elected. With the specialization of knowledge and the need of laboratories, the colleges could not give all the instruction needed, and the universities of Oxford and Cambridge are becoming increasingly teaching bodies. Parliament has required the colleges to give some part of their income to the support of the university. The professors are usually nominated by boards of electors, consisting of men of distinction in the subject or in related subjects, partly from the university and partly from outside. I have never heard of the expulsion of a fellow or professor. That a professor's salary should depend on the favor of a president or that he should be dismissed without a hearing by a president with the consent of an absentee board of trustees is a state of affairs not conceivable in an English or German university.

Harvard College was founded in 1636 by the general court of the Colony of Massachusetts Bay and placed under a board of overseers named by the court. In 1650 there was established a self-perpetuating

corporation consisting of a president, a bursar and five fellows, which, however, was made responsible to the overseers. In 1865 the election of overseers was transferred from the legislature to the alumni of the college. The Collegiate School of Connecticut, subsequently named Yale College, was chartered by the legislature of the Colony of Connecticut in 1701 and placed under the control of trustees or partners, consisting of ten reverend ministers of the gospel. In 1745 the corporation received the title of The President and Fellows of Yale College. Later the governor, the lieutenant governor and six senators of the state were added to the fellows; in 1872 alumni trustees were substituted for the senators. The College of William and Mary was chartered in 1693 by the sovereigns whose names it bears. Princeton, Pennsylvania and Columbia, chartered, respectively, in 1746, 1751 and 1754, were placed under the control of boards of trustees, and, like Harvard and Yale, either at their inception or later, were controlled by the state and received appropriations from it. In my opinion it would have been better if the relation between the state and its university had been maintained.

The colonial college was largely modeled on the Cambridge college; thus the form of the Harvard and Yale corporations—the president and fellows—was directly borrowed. At Harvard the corporation included the teachers of the college; there was much protest the first time an alumnus was elected a fellow when there was a tutor eligible. It would be interesting to trace—did time and my competence permit—the steps through which our colleges slipped from the control of the state and of the graduates and teachers into the hands of small self-perpetuating corporations, until we reach the most reactionary

of all charters, that of 1810 for Columbia College, the provisions of which are as follows:

The said trustees, and their successors, shall forever hereafter have full power and authority to direct and prescribe the course of study and the discipline to be observed in the said college, and also to select and appoint by ballot or otherwise, a president of the said college, who shall hold his office during good behaviour; and such professor or professors, tutor or tutors, to assist the president in the government and education of the students belonging to the said college, and such other officer or officers, as to the said trustees shall seem meet, all of whom shall hold their offices during the pleasure of the trustees. *Provided always*, That no such professor, tutor, or other assistant officer shall be a trustee.

The careers of our colleges were checked by political and church dissensions; thus, in the case of Columbia, the subordination of the professors is in part explained by distrust of their episcopalian tendencies. It seems that the organization of our colleges was influenced not only by the college of the English universities, but also by the English endowed public school, to which it came to bear a greater resemblance.

The University of Virginia was established as a state institution by the legislature in 1819. Under the influence of Jefferson the continental university was to a certain extent followed; and both in educational and administrative methods there was much that was admirable—at least from my point of view. Under the general control of a board, the affairs of the university were administered by the faculty and its elected chairman, until after eighty years souls were once more sold for gold. The University of Indiana was established in 1820, the University of Michigan in 1837, as part of the public educational system of those states, the governing bodies being elected boards. Here was inaugurated a new movement in higher educa-

tion, destined, I trust, to parallel the great performance of the medieval university and of the German university. The institutions of the Atlantic seaboard having slid into capitalistic control, there has arisen in the central west a system of higher education directly responsive to the will of the people on whose support it depends.

Prior to the last quarter of the nineteenth century, we had colleges and professional schools, but no university. Yale, it is true, first offered the doctorate of philosophy in 1860, and in the early seventies the degree was given by Harvard, Columbia and Cornell. But the graduate work of a faculty of philosophy was not organized or emphasized until the opening of the Johns Hopkins University in 1876, when there arose an institution nearer to my conception of what a university should be than any elsewhere in this country or than it has been able to remain. Buildings, administration and routine instruction were subordinated to great men who attracted from the whole country the students who were to be the future leaders. In the organization of the Johns Hopkins Medical School in 1893 a contribution of nearly equal significance was made in placing the professional school on a university basis. The past two or three decades have witnessed an almost incredible growth of our universities. Columbia has now 700 instructors, 7,000 students, fifty million dollars. In spite of the materialistic standards and autocratic methods of control which this paper emphasizes—perhaps overemphasizes with a view to their correction—the development of the American university, especially of the state university, is one of the greatest achievements of our people, promising moral, social and intellectual leadership and supremacy in the course of the present century.

If here or elsewhere I have expressed

opinions which seem lacking in appreciation of what is being accomplished in this country for higher education and for the advancement of science, this is only because it is not possible to put in each paragraph or even in a single paper everything that one believes. The most useful forward movements and the greatest men are subject to just criticism. It is only when the work has been accomplished and the men are dead that we may forget the faltering and the errors and eulogize the good that has been done. In our educational and scientific work, as in our business, social and political life, we must oppose with all our power the materialistic aims and autocratic usurpations which are the not unnatural accompaniments of the development of the vast resources of a new country and the passing from aristocratic to democratic control. As I wrote² before the present democratic movement had gathered its existing force:

The applications of science—which in the first instance made democracy possible by supplying the means of subsistence with possible leisure and education for all—have in their recent developments enormously complicated modern civilization. Our methods of communication, transport and trade, of manufacture, mining and farming, have led to the doing of things on an immense scale. The individual has once more been subordinated, crudely commercial standards prevail, and control has been seized by the strong and the unscrupulous. Those of us who are not ashamed to profess faith in democracy regard all this as a temporary phase, which will only last until intelligence has developed equal to the complexity of the environment. The only real danger is that instincts may become atrophied before reason is ready to take their place.

The trust promoter and insurance president, the political boss and government official, the university president and school superintendent, have assumed powers and perquisites utterly subversive of a true democracy. The bureaucracy is defended on the ground of efficiency; but efficiency is not a

final cause. To do things is not a merit regardless of what they are, and bigness is not synonymous with greatness. There is no ground for hopelessness. Of the things done the good may last and the rest may be eliminated; bigness may become greatness. The organizers of our huge corporations have in a way made history prematurely; these vast combinations were inevitable; the trouble is that they have come before we are ready to manage them. We have no evidence that people are less competent, honest and kindly than they were; it is the difficulties and the temptations that have increased.

There is ground for maintaining that the methods of the business corporation and the political machine have been somewhat wantonly applied to educational administration in this country. On the one hand, educational institutions are not and need not become so big and complex as to require the sacrifice of freedom to supposed efficiency, and, on the other hand, those who are the university—the teachers and the students who are or have been under their influence—have far more than average intelligence. . . .

In stating frankly views that are shared by a larger proportion of my colleagues than is generally supposed, I by no means wish to adopt the attitude of a pessimist. I know well from personal experience with what unflinching courtesy and ceaseless effort a university president may conduct the affairs of his difficult office. Much has been accomplished for higher education in the United States. As the industrial trusts will in the end be directed by the world's greatest democracy for the benefit of the people, so our educational system may give the material basis for an efflorescence of creative scholarship springing from a free and noble life.

My own academic experience has been mainly in the endowed institutions of the Atlantic seaboard. My father was president of Lafayette College from 1863 to 1883, during which period the teachers increased from nine to thirty, the students from 60 to 300, and the property from \$50,000 to \$1,000,000. There the personal and patriarchal system of college control was exhibited at its best. It doubtless now flourishes in many small institutions throughout the country as in the English public schools. A man such as Mark Hop-

² "The University and Business Methods," *The Independent*, December 28, 1905.

kins or Thomas Arnold has been the soul of the institution. As Matthew Arnold writes in "Rugby Chapel"

. . . to thee was it given
Many to save with thyself;
And, at the end of thy day,
O faithful shepherd! to come,
Bringing thy sheep in thy hand.

As a fellow at the Johns Hopkins University at the zenith of its great achievement, I had again opportunity to witness the system of presidential autocracy under favorable conditions. The university was dominated by one man who was personally responsible for and to its dozen professors and two hundred students. But the patriarchal system is of necessity limited to the small institution, and it is scarcely fitted to the democracy of the twentieth century. In a residence of six years at European universities, I had experience of the educational system, but though I was assistant at the University of Leipzig and lecturer at the University of Cambridge, I was at that time indifferent to administrative methods. These have been increasingly forced on my attention since my appointment as professor at the University of Pennsylvania and lecturer at Bryn Mawr College, and for the twenty years during which I have been professor at Columbia University.

I reviewed the problems of university control in a short article printed in *SCIENCE* some six years ago. This was reprinted with certain added footnotes, and at the beginning of December sent to our leading men of science, who hold or have held academic positions, with the following note:

Would you be willing to give your opinion of the plan of university control here proposed? If you are so kind as to do so, I shall understand that I may quote anonymously your reply.

About 300 replies have been received, which are printed practically in full as an

appendix to this paper. The article on which the replies were based is as follows:

UNIVERSITY CONTROL*

In the colleges from which our universities have developed the problem of administration was comparatively simple. The faculty and the president met weekly and consulted daily; each was familiar with the work of the entire institution; a spirit of cooperation and loyalty naturally prevailed. The trustees also understood the economy of the college and were able to work intelligently for the general good. But when a university covers the whole field of human knowledge, when it is concerned with professional work in divergent directions, when it adds research and creative scholarship to instruction, when both men and women are admitted, when there are 500 instructors and 5,000 students, it is no longer possible for each trustee and for each professor to share intelligently in the conduct of the whole institution. We appear at present to be between the Scylla of presidential autocracy and the Charybdis of faculty and trustee incompetence. The more incompetent the faculties become, the greater is the need for executive autocracy, and the greater the autocracy of the president, the more incompetent do the faculties become. Under these conditions it appears that the university must be completely reorganized on a representative basis. It should not be a despotism and it can not be a simple democracy. Autonomy should be given to the schools, departments or divisions. The administrative, legislative and judicial work must be done by experts, but they should represent those whom they serve. . . .

The present writer ventures to propose tentatively the following form of organization for our larger universities, to be reached as the result of a gradual evolution:†

* Reprinted from *SCIENCE*, for March 23, 1906, with footnotes added in November, 1911.

† No sensible person would attempt to reform suddenly by a paper constitution a system which has developed in response to its environment. The boss in politics, the trust magnate in business, the university president and school superintendent, have probably conduced to a certain kind of efficiency and to an enlargement more rapid than would otherwise have been possible. What a community does is dependent on the men who compose it rather than on the laws under which they live. But a bad system may demoralize the cooperative spirit of the group and may select for it individuals who are not the most desirable. The danger of our present system of university control is that

1. There should be a corporation consisting of the professors and other officers of the university, the alumni who maintain their interest in the institution and members of the community who ally themselves with it.⁵ In the case of the state universities part of the corporation would be elected by the people. This corporation should elect trustees having the ordinary functions of trustees—the care of the property and the representation of the common sense of the corporation and of the community in university policy.⁶ The trustees should elect a chancellor⁷ and a treasurer who would represent the university in its relations with the community.

2. The professors or officers, or their representatives, should elect a president who has expert knowledge of education and of university administration. His salary should not be larger, his

it tempts a man to play for his own hand and selects for academic work men lacking in character, individuality and genius.

⁵ A large corporation of this character places the ultimate control on a democratic basis. The members would pay annual dues, and a considerable income would thus accrue. A large number of individuals would take an active interest in the welfare and development of the institution. In the case of the state universities the people of the state are in a sense the corporation with ultimate control, and it might be undesirable to establish an intermediate body. Still the state might delegate its powers to such a corporation, and a society of members of the university might be formed, even though the regents or trustees were elected by the people or appointed by their elected governors.

⁶ The trustees or regents of an American university have absolute powers, but tend to delegate them to the president. They place a limit on the amount of money that can be spent and sometimes use their reserve powers even in matters of educational detail. When the corporation is small, as at Harvard, it may be in active control of policies. In the private chartered institutions it is usually large, its members having but little knowledge of educational problems or of the special university under their control. There are often several trustees who take an active, though not always a wise, interest in the university, and it is a delicate problem of the president to manage such trustees. One of the most serious difficulties of the present situation is that the president owes his office, salary and powers to the trustees and must obtain their favor, whereas he is not responsible to the faculties. The professor is likely to owe his office and salary to the president, and is sometimes placed in a position that is humiliating.

⁷ It might or might not be an advantage to have a chancellor, such as exists in the British universities, a man of prominence in the community, who would obtain endowments and represent the university at public functions.

position more dignified or his powers greater than those of the professor.⁸

3. The unit of organization within the university should be the school, division or department, a group of men having common objects and interests, who can meet frequently and see each other daily. It should be large enough to meet for deliberation and to represent diverse points of view, but small enough for each to understand the whole and to feel responsible for it. The size of this group is prescribed by a psychological constant, its efficient maximum being about twenty men and its minimum about ten.⁹

4. Each school, division or department should elect its dean or chairman and its executive committee, and have as complete autonomy as is consistent with the welfare of the university as a whole.¹⁰ It should elect its minor officers and nominate its professors. The nominations for pro-

⁸ It may be that no president is desirable other than an annually elected rector, as in the German universities. If, however, the president were elected by the faculties for a limited term and made responsible to them, the academic situation would be greatly improved. The argument of efficiency can be adduced in favor of giving autocratic powers to one individual, but the university is the last place where such system should prevail. It is neither necessary nor desirable that things be done in haste. Administrative details can be handled promptly by a clerk or secretary. Men and women should not be subject to the judgment or whims of an individual. Security, permanence, honor, the slow growth of traditions, are essential to a true university.

⁹ Such autonomy is usually possessed by medical, law and technical schools forming a part of a university. It should be extended to other divisions when they become sufficiently large. Partly independent institutions for teaching or research can to advantage form part of a university. The separately endowed colleges of the English universities have certain advantages.

¹⁰ In the department-store system, which is likely to prevail in our universities, the junior professors and instructors are responsible to the head of the department and are dependent on him for advances in office and salary, while the heads of departments are in like position in relation to the dean or the president, the heads of departments and deans being named by the president. The active committees are appointed by the president; in one of our leading universities even faculty members are named by the president from among the professors, making the faculty a presidential committee. This procedure reverses the proper or, at all events, the democratic method of control, according to which officers are chosen by those whom they serve and leaders are followed because they are acknowledged as such.

fessorships should be subject to the approval of a board of advisers constituted for each department, consisting, say, of two members of the department, two experts in the subject outside the university and two professors from related departments. The final election should be by a university senate, subject to the veto of the trustees. The same salaries should be paid for the same office and the same amount of work. The election should be for life, except in the case of impeachment after trial.¹¹ The division should have financial as well as educational autonomy. Its income should be held as a trust fund and it should be encouraged to increase this fund.

5. The departments or divisions should elect representatives for such committees as are needed when they have common interests, and to a senate which should legislate for the university as a whole and be a body coordinate with the trustees. It should have an executive committee which would meet with a similar committee of the trustees. There should also on special occasions be plenums of divisions having interests in common and plenums of all the professors or officers of the university.¹² There should be as much flexibility and as complete anarchy throughout the university as is consistent with unity and order.

It seems that the 299 replies expressing the opinion of the writers on this paper

¹¹ The greatest possible care should be exercised in the selection of professors. Instructors and lecturers should be freely admitted to the university, but the professorship should be maintained as a high office. The alternative to permanence of tenure is competition for prizes under honorable conditions, but in this case salaries must be as large as the incomes of leaders in law, medicine and engineering. It is more economical and probably conduces to greater dignity and honor to pay adequate but moderate salaries with permanence of tenure, as in the army or the supreme court. Advances in salary should be automatic, as at Harvard, but there might to advantage be a few professorships with comparatively high salaries—the same as that of the presidency—vacancies in which would be filled by cooptation or by election by the faculties.

¹² Professors and other officers should not be distracted from their work of teaching and research by administrative politics. But they should select their administrative officers and legislative committees and have opportunity to make proposals and vote on questions of educational policy. Voting by mail and the fly-leaf method of discussion of the English universities could be adopted to advantage. An elected executive committee of the faculties meeting with the executive committee of the trustees is a feasible method of improving the existing academic situation.

represent with considerable accuracy the existing academic sentiment in this country among those who have been most successful in their work. They are all from men in the natural and exact sciences, who form somewhat less than half our university professors, but there is no reason to suppose that their colleagues in other departments would differ as a class in their attitude on academic questions. I wrote to scientific men because I had a list of those of highest standing and am personally acquainted with most of them. It may be that in some cases men were more likely to reply because they agreed with my views and were more likely to emphasize their agreement than their dissent. As a psychologist by trade, I judge, however, that this is more than balanced by the opposite tendency to react by objecting and to argue against a proposition proposed. Probably the replies of younger men and of less successful men would be more radical and more opposed to the existing system of university control.

The letters are well worth a careful reading. We are told that every question has two sides; as a matter of fact many questions are polygons. The problems of the administration of an educational institution have many sides and many angles. They differ completely in the small college and in the large university, in the newer and in the older institutions, in the state university and in the private corporation. My paper was written with reference to the large endowed universities, especially those which have enjoyed or suffered a rapid growth in size and scope. The replies are from institutions of all kinds. Those who hold chairs in the smaller colleges may find a system fairly adequate to their needs which would be undesirable in our large universities. Those in state universities may regard as

necessary a strong executive responsible to the people and professors subordinated to the public service, when they would not approve of the irresponsible autocracy of the private corporations. Professors at Harvard and Yale may take satisfaction in the long traditions and wise precedents which obtain at these universities, when they would not care to live under the system in use at Columbia and Chicago.

It was originally my intention to base this paper on an analysis of the letters received, but the exigencies of an engagement made it necessary to prepare its first version before the proofs could be obtained, the letters written and the replies received. It is indeed somewhat difficult to summarize such a large number of points of view which represent both real differences of opinion and differences due to the fact that various situations were under consideration. It seems best to print the letters, and to permit those interested to draw their own conclusions. The letters will be given under the institution from which they come when there are as many as ten replies, the institutions otherwise being grouped. In general, the letters are placed in the order of their preference for the existing system of university control which I designate as a limited autocracy. Omissions have been made from some of the longer letters and, formal compliments, apologies and the like have been erased. Thus a large percentage of all letters begin with the phrase "I have read with interest," etc. Other slight editorial revision, such as eliminating the paragraphs, has been undertaken, but every effort has been made not to alter in the slightest degree the opinions expressed. There is given here a table showing the source of the replies and the only classification that I shall attempt to make. Its validity can be

judged by those who care to read the letters.

	Limited Autoc- racy Present System	Greater Faculty Control	Representative Democ- racy; Plan Proposed	Total
Harvard	9	6	11	26
Yale	1	6	4	11
Columbia	2	2	10	14
Pennsylvania	0	3	9	12
Johns Hopkins	0	2	14	16
Chicago	1	0	17	18
Cornell	0	4	8	12
Mass. Inst.	3	4	3	10
New England	6	6	12	24
Middle States	3	4	21	28
Col. for Women	1	2	5	8
Southern	1	3	9	13
Michigan	0	3	7	10
Wisconsin	5	4	4	13
Minn. Ill. Mo. Cal.	5	5	18	28
C. & W. State	2	7	14	23
C. & W. Private	7	7	16	30
Anonymous	0	1	2	3
Total	46	69	184	299

Of the 299 replies 46 are taken as favoring the system usual in this country, which is designated as a limited autocracy, 69 as favoring a system in which the faculties have greater share in control, as at Yale or the Johns Hopkins Medical School, 184 as favoring a plan of representative democracy more or less similar to the one proposed. Five sixths of those holding the most important scientific chairs at our universities believe that there should be a change in administrative methods in the direction of limiting the powers of the president and other executive officers and making them responsible to those engaged in the work of teaching and research. This is an agreement greater than I had anticipated. When eighty-five per cent. of those responsible for the conduct of a given system unite in holding that it should be altered, the case may be regarded as strong. Political and social changes are usually made on a much narrower majority. It is true that five of the six presidents who replied—they are of course

at the same time men who formerly did distinguished scientific work—form part of the minority. Indeed, a large percentage of this minority consists of presidents, directors, deans and other university officials.¹³ Whether this should be interpreted as that much in favor of the present system, or that much more against it, may be left an open question.

A considerable number of professors at Harvard favor the existing system, but their preference applies to their own situation, where the administrative autocracy is tempered. Of 19 replies from Wisconsin and Illinois, eight favor a limited autocracy, but they have in mind their system, which is not the same as that of the private universities. Probably they would in any case prefer the methods of President Van Hise and President James to those of President Draper. Those who want a strong executive responsible to the people of the state have been classed in the group favoring a limited autocracy. Thus the two replies from Columbia which are placed in this group are from men who do not trust faculty control, though, as I happen to know, they are by no means satisfied with the existing situation. If these two cases are omitted, we find that of 70 replies from Columbia, Pennsylvania, Cornell, Johns Hopkins and Chicago—these are the institutions which I had especially in mind in my proposals—only one (an executive officer) favors the existing system, eleven favor greater faculty control, and 58 a

¹³ Eighteen of the replies are from men who formerly held academic positions but are now connected with research institutions, the government service, etc., or who while holding professorships are principally engaged in other work. These replies show about the same distribution as the others, three in the first group, four in the second and eleven in the third. They are classed under the institutions with which the men are or were connected. Two replies from those previously connected with universities as teachers, but somewhat incidentally, have been omitted. They both belong to the third group.

complete change which would make the administration responsible to the faculties. This is surely a condition which foretells reform or bankruptcy.

J. McKEEN CATTELL

(To be continued)

ABBOTT LAWRENCE ROTCH¹

ABBOTT LAWRENCE ROTCH was born in Boston, January 6, 1861, the son of Benjamin Smith and Anna Bigelow (Lawrence) Rotch. He was graduated from the Massachusetts Institute of Technology (S.B.) in 1884. In 1891 Harvard recognized the importance of the work which he had already accomplished by bestowing upon him the honorary degree of A.M. From 1888 to 1891, and again from 1902 to 1906, he held the appointment of assistant in meteorology at Harvard, a position which involved no teaching and in which no salary was paid. In 1906 he was appointed professor of meteorology, an honor which he prized very highly, and which gave him the position on the teaching staff of the university to which he was in every way fully entitled. He was the first professor of meteorology who has occupied that position at Harvard, and he served in this professorship without pay. In the year 1908-09, at the request of the department of geology and geography, he generously put the splendid instrumental equipment and library of Blue Hill Observatory at the service of the university, by offering a research course ("Geology 20f") to students who were competent to carry on investigations in advanced meteorology. This action on the part of Professor Rotch gave Harvard a position wholly unique among the universities of the United States. It brought about a close affiliation, for purposes of instruction and of research, between the university and one of the best-equipped meteorological observatories in the world. To his work as instructor Professor Rotch gladly gave of his time and of his means. He fully realized the unusual ad-

¹ An appreciation of Professor A. Lawrence Rotch, based on the same material, appears also in the *Harvard Graduates' Magazine*.—R. DeC. W.

vantages which he was thus enabled to offer those students who were devoting themselves to the science of meteorology, and the experience of the men who had the privilege of his advice and help in the work at Blue Hill shows clearly how much they profited by this opportunity. Only a short time before his death he had expressed the wish to bring about a still closer connection, for purposes of instruction, between the university and Blue Hill Observatory. He thus showed his appreciation of the importance of the new field of work which he had undertaken.

While thus planning still further usefulness for his observatory; in the midst of a life singularly active; with an ever-widening sphere of scientific influence and a constantly increasing importance of his contributions to meteorology, Professor Rotch died suddenly in Boston on April 7, 1912, in the fifty-second year of his age. His wife, who was Miss Margaret Randolph Anderson, of Savannah, Ga., and three children survive him.

Professor Rotch early developed that absorbing interest in meteorology which caused him to devote his life to the advancement of that science. Possessed of large means, he preferred to work persistently, and not infrequently to undergo discomfort and hardship in his chosen field of research, rather than to live a life of ease. Realizing the need of an institution which could be devoted to the collection of meteorological observations, and to meteorological research, free from any entanglements, he established, in 1885, Blue Hill Observatory. This was first occupied by Mr. Rotch and his observer, Mr. W. P. Gerrish, on February 1, 1885. This observatory he not only equipped and maintained until his death, but he made provision in his will for having the work there carried on without a break. Blue Hill Observatory is to-day one of the few private meteorological observatories in the world, and there is not one which is better equipped. In fact, it is probably safe to say that there is no private scientific establishment which is better known for the high standard of its work. The Blue Hill Observatory was, with the exception of

the municipal meteorological station in New York, the first in this country to be equipped with self-recording instruments, and it is to-day one of the comparatively few in the world where nearly every meteorological element is continuously recorded. Beginning with 1886, hourly values have been printed. Professor Rotch took a splendid pride in his observatory, and in its equipment, and his library, to which he devoted constant care, was one of the most complete and valuable in the world.

Professor Rotch early realized that the advance of meteorology must come through a study of the free air, and with keen and prophetic judgment he planned and carried out the remarkable series of investigations which have made Blue Hill so famous. He secured assistants who were well fitted to carry out the researches which he planned and supervised. He thus showed his ability to judge the value of men, as well as his capacity to organize the work for them to do. Mr. H. H. Clayton became a member of the Observatory staff in 1886, and served, as observer and meteorologist, with some interruptions, for twenty-three years. His work brought distinction to himself and to the observatory. Mr. S. P. Ferguson joined the staff in 1887, and remained there until 1910. Many new instruments were devised by him, and perfected with care and success. Mr. A. E. Sweetland died after eight years of service and was succeeded, in 1903, by Mr. L. A. Wells, who is now observer-in-charge, with Mr. A. H. Palmer as research-assistant. Year after year the Blue Hill publications have contained results of far-reaching importance. It is not an exaggeration to say that much of the recent rapid advance of meteorological science is due to the pioneer work which was done at Blue Hill.

Under an arrangement entered into between Blue Hill Observatory and the Astronomical Observatory of Harvard College, Professor Rotch was, for nearly twenty-five years, closely associated with the latter institution. All of the observations made at Blue Hill were published in the *Annals* of the Harvard Observatory, and fill eight quarto volumes.

The international form of publication, and metric units, were first used in the United States in the publications of the Blue Hill Observatory.

It was one of Professor Rotch's most striking characteristics that he never neglected any opportunity which might help him to keep his observatory not only abreast of the times but ahead of the times. He thought nothing of the time and the expense of taking a trip to Europe in order to attend some scientific meeting, meteorological or aeronautical, if he believed, as he most firmly did, that he might by so doing gain inspiration and new ideas. Few scientific men are so regular in their attendance at congresses and meetings; few contribute so much that is new or gain as much inspiration as he did at such gatherings. It was not the blind following of the dictates of his New England conscience that prompted him to be so regular in his meetings with his scientific colleagues. His motive was a higher one than that. It was his absorbing desire to advance his science by every means within his power. The list of scientific bodies of which he was a member was a long one, but every one of them gained much from his membership and from his presence at its meetings. He was regular in his attendance; always ready to contribute papers; always modest in his estimate of the importance of his own work; always generous in his appreciation of the work of others; always ready with a word of sympathy, or encouragement, or fellowship.

The productivity of Blue Hill Observatory has been remarkable, especially when it is remembered that this activity was the result of the support and inspiration of one man. The study of cloud heights, velocities, movements and methods of formation at Blue Hill was one of the most complete investigations of the kind ever undertaken. The first series of measurements in America of the height and velocity of clouds, by trigonometrical and other methods, was made at Blue Hill in 1890-91. These measurements were repeated in 1896-97, as a part of an international system.

It was at Blue Hill that the modern methods of sounding the air by means of self-recording instruments lifted by kites were first developed and effectively put into practise (1894), methods which have now been adopted by meteorological services and scientific expeditions in all parts of the world. The use of cellular kites flown with steel wire and controlled by a power windlass originated at Blue Hill. Grants for carrying on this kite work were obtained from the Hodgkins Fund.

It was Rotch who, in 1901, during a voyage across the Atlantic, first obtained meteorological observations by means of kites flown from the deck of a moving steamer, thus indicating the feasibility of a new way of securing information concerning the conditions of the free air over oceans and lakes. It was Rotch who, in 1904, secured the first meteorological observations by means of sounding balloons from heights of 5 to 10 miles over the American continent, and who, in 1909, made the first trigonometrical measurements of the flight of pilot balloons in the United States. In 1905-06 he joined his colleague, Teisserenc de Bort, in fitting out and taking part in an expedition to explore the tropical atmosphere over the Atlantic Ocean by means of kites and pilot balloons, an undertaking which resulted in the collection of important data regarding the temperatures and movements of the upper air. But Rotch was not content with merely sending up kites and balloons. His enthusiasm in the study of the free air, and his desire to visit the mountain observatories of the world, led him to become a mountain climber of no mean ability. He ascended to the summit of Mont Blanc at least five times, and in South America and elsewhere he himself made meteorological observations at considerable altitudes on mountains, and carefully observed the physiological effects of the diminished pressure. He also took part in several balloon ascents, and was a member of more than one solar eclipse expedition. His studies of eclipse meteorology are among the most complete which have been made. Among his many contributions to the advancement of meteorology must also be mentioned his in-

vention of an instrument for determining the true direction and velocity of the wind at sea.

Professor Rotch was naturally intensely interested in the recent rapid development of aeronautics. His earlier training at the Massachusetts Institute of Technology, and his untiring zeal in the exploration of the upper air, combined to give him this interest. He turned his attention largely in that direction of late years. It was characteristic of him that, not content with the mere collection of data, and with investigations of theoretical interest, he always strove to make these results of practical use. Thus, soon after the establishment of his observatory, the issue of local weather forecasts was begun, and one of the last things which he published (in association with Mr. A. H. Palmer) was a set of "Charts of the Atmosphere for Aeronauts" confined to meteorology, and show most embodying many of the results of observations made at Blue Hill in a practical form for the use of airmen.

Professor Rotch's list of published papers and books comprises 183 titles. These cover a wide range of subjects, by no means strictly confined to meteorology, and show most emphatically how varied were their author's interests; how extended was his reading; how alert and progressive he was in all he undertook. These 183 titles in themselves furnish a satisfactory outline of the development of meteorological science during the past 25 years. In addition to the "Charts of the Atmosphere" just referred to, he published two other books, "Sounding the Ocean of Air" (1900) and "The Conquest of the Air" (1909).

Professor Rotch gave his support freely to a large number of scientific societies and undertakings. He was one of the pioneer and most enthusiastic members of the New England Meteorological Society. He was, for more than ten years (1886-96), one of the associate editors and one of the mainstays of the *American Meteorological Journal*, which did a unique work for American meteorology. He was a member of the Astronomical and Astro-

physical Society of America; a fellow and of late years librarian of the American Academy of Arts and Sciences; a member and trustee of the Boston Society of Natural History; a member of the American Philosophical Society, of the Physical Society of London, of the International Solar Commission, of the International Commission for Scientific Aeronautics, of the International Meteorological Committee; fellow of the Royal Meteorological Society (London); member of the Société Météorologique de France, of the Deutsche Meteorologische Gesellschaft, of the Oesterreichische Gesellschaft für Meteorologie and of many other societies.

He was lecturer at the Lowell Institute, in Boston, in 1891, and again in 1898. He was a member of the International Jury of Awards at the Paris Exposition (1889), and was then made a Chevalier of the Legion of Honor. He received the Prussian Orders of the Crown (1902) and Red Eagle (1905) of the Third Class in recognition of his services in advancing the knowledge of the atmosphere. The latest evidence of the high regard in which his scientific work was held abroad was his selection, by the French ministry of public instruction, as exchange professor at the Sorbonne for the year 1912-13. The official letter announcing this selection arrived in this country within a very few days after Professor Rotch's death.

He was a pioneer in a new science; an investigator, whose name is known wherever meteorological work is done; a loyal teacher who served without salary; a generous benefactor, who left to the university an enduring monument of his enthusiasm and untiring devotion to the science which he himself did so much to advance. His life and labor have been an inspiration to his scientific colleagues everywhere, but especially to those who were most closely associated with him in the work of his observatory, and in the department of the university of whose staff he was a valued member.

ROBERT DE C. WARD

HARVARD UNIVERSITY

*THE TRANSCONTINENTAL EXCURSION OF
THE AMERICAN GEOGRAPHICAL
SOCIETY*

THE American Geographical Society of New York celebrates this year the occupation of its new building on Broadway at 156th Street and the sixtieth anniversary of its founding. No form of celebration seemed so fitting as an excursion across the United States, in which an invited party of European geographers should make the journey in company with a number of American geographers, who would show the visitors the most significant of our geographical features; the excursion to be closed by a meeting in New York, when the visitors should be invited to give some account of what they have seen.

The plan thus outlined is now approaching its realization. The leading geographical societies of over a dozen European countries have been requested to select from among their members a number of proficient geographers whom the American Geographical Society may welcome on the excursion. The list thus constituted, with the addition of a few names otherwise invited, now includes over forty geographers from sixteen different countries; most of the delegates being professors in universities or officers of national geographic societies. The character of the party will be sufficiently indicated by announcing the coming of Partsch and Drygalski, Merzbacher and Jaeger, of Germany; Gallois, Margerie and Vacher, of France; Chisholm, Becket and Falconer, of Great Britain; Niermeyer and Oestreich, of Holland; Leconte, of Belgium; Beltrán, of Spain; Silva-Telles, of Portugal; Brückner and Oberhummer, of Austria; Cholnoky and Teleki, of Hungary; Cvijić, of Serbia; Doubiansky and Schokalsky, of Russia; Andersson, of Sweden; Olufsen, of Denmark; Brunhes, Chaix and Nussbaum, of Switzerland, and Calciati, Marinelli and Vinciguerra, of Italy. It is safe to say that no such gathering of geographical crowned heads has ever been brought from Europe to America.

The Americans already enlisted, either as round-trip or as temporary members, include,

among professors of geography, Barrows and Cowles, of Chicago; Brigham, of Colgate; Bowman, of Yale; Davis and Ward, of Harvard; Dodge and Johnson, of Columbia; Fenneman, of Cincinnati; Jefferson, of Ypsilanti, and Martin and Whitbeck, of Wisconsin, as well as a number of scientific men from various parts of the country representing subjects allied to geography. Professor W. M. Davis, of Harvard University, has been appointed director of the excursion. The party as now made up includes over fifty round-trip members and some twenty or more temporary members. The number of participants is still to be somewhat enlarged, and correspondence (addressed to the director, Transcontinental Excursion American Geographical Society, Broadway at 156th Street, New York) is therefore invited from proficient geographers (men only) who may desire to take part in the excursion for longer or shorter periods, and who can aid the American members already enlisted in explaining our geographical features to the European members. Place on the special train in which the excursion will be made can not be promised to all applicants, but it is hoped that all professional geographers who wish to take part in the excursion can be accommodated in one or another part of the route. The excursion train will leave New York about August 22, and return in the early part of October.

The route of the excursion includes Niagara, Detroit, Chicago, Madison, St. Paul, Minneapolis—probably Duluth and the Iron region—the Yellowstone Park, Spokane, Seattle, Tacoma, Portland—probably San Francisco, possibly the Yosemite Valley—Salt Lake City, Grand Junction, Denver, Albuquerque, the Grand Canyon of the Colorado in northern Arizona, Kansas City, St. Louis—possibly Memphis, Birmingham and Chattanooga—Washington and New York. Numerous stops will be made at points of geographical interest on the way. A most generous hospitality is promised at many places, where the party will be entertained in local clubs and taken about in automobiles. The cities of the far northwest are particularly

active; they are planning to take the excursionists up Mt. Rainier through the superb forest that clothes the lower slopes of this great volcano, to the hotel situated near the timberline, whence the glaciers of the higher slopes may be seen; and also to Crater Lake, the waters of which occupy a huge cavity of engulfment in a once lofty volcano, one of the most remarkable features of the west, although as yet not widely known. Two days will be spent in Washington, where visits will be made to various scientific bureaus of the government. The final meeting in New York will be made the occasion of a more general invitation than can be given for a limited excursion on a railway train; and at that time, it is desired that the European geographers should have opportunity of meeting a large number of their American colleagues. Due announcement will be made of the place and date of this final meeting, as well as of the speakers and the subjects that they will treat.

SCIENTIFIC NOTES AND NEWS

At the meeting of the London Institution of Electrical Engineers on May 16, a marble bust of the late Lord Kelvin was presented to the institution on behalf of Lady Kelvin.

SOME of the associates and students of Dr. Simon Flexner during the period from 1899 to 1904, when he was professor of pathology at the University of Pennsylvania, have presented to the university a portrait showing Dr. Flexner in his laboratory, painted by Adele Herter, of New York City.

At the annual meeting of the American Academy of Arts and Sciences, held on May 8, 1912, it was voted, upon the recommendation of the Rumford Committee, to award the Rumford premium to Frederic Eugene Ives for his optical inventions, particularly in color photography and photo-engraving.

THE Bessemer gold medal of the British Iron and Steel Institute has been awarded to Mr. John Henry Darby. Mr. Darby's connection with the iron and steel trades is best known from his association, as far back as in

the year 1880, with the introduction of the basic process. The first open-hearth furnaces for the manufacture of steel on a large scale erected in Great Britain were those built under Mr. Darby's superintendence at Brymbo.

THE congratulations of the council of the Chemical Society, London, have been offered to Mr. E. Riley, who has completed sixty years of fellowship, and to Major C. E. Beadnell, R.A., Mr. H. O. Huskisson and Mr. F. Norrington, who, during 1911, attained their jubilee as fellows.

MR. MARK A. CARLETON, for the past eighteen years in charge of grain investigations in the Bureau of Plant Industry, and well known as the introducer and propagator of Durum wheat and the Swedish select oat, has resigned his present position to take charge of the work of the Pennsylvania Chestnut Tree Blight Commission.

MR. C. E. CRAIG, instructor in agronomy in Purdue University, has accepted the position of agronomist in the Polytechnic School at Porto Alegre, Brazil.

DR. MAURICE J. BABB, assistant professor of mathematics at the University of Pennsylvania, has been elected president of the Association of Teachers of Mathematics of the Middle States and Maryland.

MR. H. C. K. PLUMMER has been elected, as we learn from *Nature*, by the board of Trinity College, Dublin, to be royal astronomer in Ireland, in succession to Dr. E. T. Whittaker, who was recently elected professor of mathematics at Edinburgh University. Mr. Plummer is the son of Mr. W. E. Plummer, director of the Liverpool Observatory, and has been second assistant to Professor H. H. Turner at the Oxford University Observatory since 1901.

At the annual meeting of the British Institution of Civil Engineers, held on April 30, the following were elected president and vice-presidents: *President*, Mr. Robert Elliott-Cooper; *vice-presidents*, Mr. A. G. Lyster, Mr. B. H. Blyth, Mr. J. Strain and Mr. G. Robert Jebb. The council of the institution has made the following awards for papers read

during the session 1911-12: Telford gold medals to Messrs. E. and W. Mansergh; a George Stephenson gold medal to Mr. R. T. Smith; a Watt gold medal to Mr. A. H. Roberts; Telford premiums to Messrs. J. Goodman, A. B. McDonald, G. M. Taylor, D. C. Leitch, W. C. Easton and D. H. Morton; and the Manby premium to Mr. S. H. Ellis.

At his own request and on account of physical disability, after a steady teaching service of over thirty-six years, by vote of the board of regents of the University of Minnesota, Arthur E. Haynes, professor of engineering mathematics, has been retired. The board has passed the following resolution: "Voted to express the appreciation of the board not only of the professional services of Professor Haynes, but of his personal devotion, his influence for the highest type of living and his loyalty to the university."

MR. WALTER E. ARCHER, C.B., who, as assistant secretary, has been in charge of the Fisheries Division of the Board of Agriculture and Fisheries since its establishment in October, 1903, has been compelled to retire from the public service owing to ill-health. His retirement took effect on May 1.

It is stated in *Nature* that the services of the official guide to the collections at the British Museum, Bloomsbury, have been so highly appreciated that a similar officer has been appointed, experimentally, at the Natural History Museum, South Kensington. Mr. J. H. Leonard has been selected for the position. The guide will make two tours of the museum daily, each tour lasting an hour. Provision will also be made for special tours, and for these, special application will have to be made.

The consul general of Uruguay and six members of a commission of agricultural engineering are visiting our colleges of agriculture. The commission is on a world tour to study agriculture in different countries.

PROFESSOR HENRY B. WARD spoke on May 8 before the Medical Research Club of Cincinnati on "Recent Discoveries of Value in the Accurate Diagnosis of Human Parasites," illustrating the talk with material from the

zoological research laboratory of the University of Illinois. On May 10 he delivered the convocation address at the University of Cincinnati on the topic "The Prolongation of Life." While in Cincinnati he met with the committee of the university on the formulation of a constitution and at the request of President Charles W. Dabney discussed some of the general problems involved in this work.

PROFESSOR LAUDER W. JONES, University of Cincinnati, lectured before the students of chemistry, Central University of Kentucky, Danville, on Friday, May 10, his subject being "Some Historic Text-books and their Authors."

ON May 14 Professor W. Bateson gave the first of two lectures at the Royal Institution on "The Study of Genetics."

It is proposed to endow a pathological laboratory at St. Vincent's Hospital, New York, as a memorial of Dr. William Francis Norman O'Loughlin, the senior medical officer of the *Titanic*, in which he went down after rendering all possible assistance in saving others. Dr. O'Loughlin had been forty years in the service of the White Star Line.

PRINCE DAMRONG, minister of the interior in Siam, has founded a Pasteur Institute in memory of his daughter, who died of hydrophobia.

SIR FREDERICK WALLACE, an eminent London surgeon, has died at the age of fifty-three years.

THE death is also announced of M. Eugene Caventou, the distinguished organic chemist, president of the Paris Academy of Medicine in 1897.

THERE is existing a vacancy in the position of chief of drainage investigations in the Office of Experiment Stations, Department of Agriculture, Washington, D. C., at a salary of about \$4,000 per annum. The government is endeavoring to find the best man available for this work and has no particular individual in view. Applications for the examination will be accepted until June 10. Applicants should have a broad training in civil engineer-

ing; experience in making and passing upon drainage surveys and plans, with special reference to the requirements of the drainage of large tracts of agricultural lands; familiarity with drainage laws and administrative organization, cost of construction of drainage systems, etc. They should also be qualified to plan and conduct research along drainage lines, and to make reports and prepare publications on drainage subjects. Five years' experience as a drainage or hydraulic engineer, exclusive of any similar experience obtained in connection with university studies, is a prerequisite for consideration for this position.

THE U. S. Civil Service Commission also announces an examination to fill a vacancy in the position of assistant pharmacologist in the Bureau of Chemistry, at \$1,800 to \$2,000 per annum. This position affords opportunity for study and research in pharmacology and physiology in the broadest sense, the laboratory equipment being of the best. The person appointed to this position, if he proves capable of conducting the work, may expect reasonable promotion.

AN invested fortune yielding \$100,000 annually, a palatial mansion on the Boulevard Haussmann, and one of the finest private art collections in Europe have been bequeathed to the Institute of France by Mme. Edouard André.

THE Austrian government has purchased for about \$600,000 the only two radium mines at Joachimsthal which were owned by private individuals. It is estimated that the two mines will yield annually about 3 grams of radium. Plans are under way for the development of Joachimsthal as a resort for the treatment of disease by radium.

A PARTY will leave Cornell University on May 25 for the purpose of investigating the biology of the Okefenokee Swamp in southeastern Georgia. The fauna and flora of this extensive and in many respects unique swamp have heretofore almost entirely escaped the attention of naturalists. The eastern part of the swamp consists of vast inundated

"prairies," while on the western side there are extensive heavily wooded islands. Much of the swamp is a sphagnum bog, whence the Indian name, originally spelled "Ouaquaphenogaw," meaning "trembling-earth." The personnel of the party will consist of Professors C. R. Crosby and J. Chester Bradley, Dr. A. H. Wright, Messrs. M. D. Funkhouser, M. D. Leonard, A. R. Cahn and S. C. Bishop, of Cornell University, and F. Lee Worsham, state entomologist of Georgia. Dr. Wright and Mr. Cahn will give their attention to the vertebrates, and Mr. Cahn also to collecting fleas and Mallophaga. An extensive series of blood smears will be made, for the detection of blood-parasites. The other members of the party will devote their attention to insects, especial attention being given to aquatic forms. The party expect to remain in the swamp from eight to ten weeks.

Two more American professors will start in a short time on a trip around the world under the Kahn Foundation for the Foreign Travel of American Teachers. They are William Erskine Kellicott, Ph.D., professor of biology in Goucher College, Baltimore, Md., and Ivan Mortimer Linforth, A.B., A.M., professor of Greek in the University of California, their appointment having been made this week. The fellowships to which they have been appointed carry with them a stipend of \$3,000 each, and an additional \$300 for the purchase of souvenirs, books, etc. The fellowships are unique in that the incumbents are required only to make the trip around the world. The choice of routes, countries visited and length of stay in any one place are left to the discretion of the fellows, their only duty being to see as many peoples and countries as possible. The object of the founder was to give teachers an opportunity to carry on their work from a broader and more international point of view. The first appointments on this foundation were made last year. Francis Daniels, A.B., A.M., Ph.D., professor of Romance languages at Wabash College, Crawfordsville, Ind., and John Hanson Thomas McPherson, A.B., Ph.D., professor of history and political science at the Univer-

sity of Georgia, are now abroad, and are due to reach this country during the summer months. The foundation was established by M. Albert Kahn, of Paris, France, and is administered by Edward D. Adams, Nicholas Murray Butler and Henry Fairfield Osborn, of New York City, Charles W. Eliot, of Cambridge, Mass., Charles D. Walcott, of Washington, D. C., and Frank D. Fackenthal, secretary of Columbia University, as secretary of the board.

THE Bureau of American Ethnology of the Smithsonian Institution has issued a dictionary of the Biloxi and Ofo languages, accompanied by texts of a number of stories embodying mythology and folklore of the two tribes. This volume is largely the result of painstaking investigation and study on the part of the late Rev. J. Owen Dorsey, to which Dr. John R. Swanton, of the bureau, has added the Ofo material, besides arranging and editing (from the linguistic point of view) the entire work.

MESSRS. WITHERBY & Co. are shortly publishing "A Hand-list of British Birds," giving a detailed account of the distribution of each bird in the British Isles, and a general account of its range abroad, together with details of the occurrences of rarities. The Hand-list is the joint work of Messrs. E. Hartert, F. C. R. Jourdain, N. F. Ticehurst and H. F. Witherby.

EXPERIMENTS have been carried out at Nawalia, Northern Rhodesia, respecting the transmission of human trypanosomes by *Glossina morsitans* Westw., and on the occurrence of human trypanosomes in game. The results, so far as they are at present ascertained, are presented by Mr. Allan Kinghorn and Dr. Warrington Yorke in the "Annals of Tropical Medicine and Parasitology," issued by the Liverpool School of Tropical Medicine, forming the first interim report of the Luangwa Sleeping Sickness Commission, British South Africa Company. The summary of the report as given in the London *Times* is as follows: (1) The human trypanosome, in the Luangwa Valley, is transmitted

by *Glossina morsitans* Westw. (2) Approximately 5 per cent. (4.76) of the flies may become permanently infected and capable of transmitting the virus. (3) The period which elapses between the infecting feed of the flies and the date on which they become infective is approximately 14 days. (4) An infected fly retains the power of transmitting the disease during its life, and is infective at each meal. (5) Mechanical transmission does not occur if a period of 24 hours has elapsed since the infecting meal. (6) Some evidence exists to show that in the interval between the infecting feed and the date on which transmission becomes possible the parasites found in the flies are non-infective. (7) *Glossina morsitans*, ... nature, has been found to transmit the human trypanosome. (8) Certain species of buck, viz., waterbuck, hartebeest, mpala and warthog, have been found to be infected with the human trypanosome. (9) A native dog has been found to be infected with the human trypanosome.

UNIVERSITY AND EDUCATIONAL NEWS

MRS. JOHN STEWART KENNEDY has given to New York University a Hall of Philosophy, costing in the neighborhood of \$90,000. It is to be known as the Cornelius Baker Hall of Philosophy in memory of Mrs. Kennedy's father, who was one of the founders of the university.

OBERLIN COLLEGE has received an anonymous gift of \$10,000 for library endowment. It is expected that a considerable portion of this will be devoted to completing the files of scientific periodicals and journals, with especial emphasis on the contemporary literature on Eugenics.

THE King of Siam has sanctioned a scheme for the establishment of a University of Bangkok. There will be eight faculties, including medicine, law, engineering, agriculture, commerce, pedagogy and political science.

The *Experiment Station Record* states that an agricultural school is to be established in Melilla, Morocco, under Spanish auspices. This school will have for its objects the dis-

seminating of practical instruction regarding improved methods, and their demonstration upon the estate, which will be conducted as a model farm, and also on demonstration fields in adjoining sections. It is estimated that about \$48,000 for buildings and equipment, and \$21,000 annually for maintenance, will be required.

THE William Rainey Harper Memorial Library at the University of Chicago is to be dedicated on June 10 and 11, 1912. A special effort will be made to have the alumni attend the dedicatory exercises, which will be held in Harper Court, bounded on the south by the Library, on the west by Haskell Oriental Museum, and on the east by the Law Building. For the next few years the first floor of the new building will be used for class-rooms and will also contain the Harper Assembly room. Eventually, however, the entire floor is to be utilized as a stack-room.

THE trustees of Cornell University have voted to approve the recommendation of the faculty of the College of Agriculture and the university faculty to grant hereafter the degree of bachelor of science, instead of bachelor of science in agriculture, for the completion of the course in the College of Agriculture.

AT Princeton University, William F. Magie, Henry professor of physics, has been elected dean of the faculty to succeed Professor H. B. Fine. Professor Fine retains the deanship of the department of science. He will spend the coming academic year in Europe.

DR. M. E. WADSWORTH, for the past five years dean of the School of Mines of the University of Pittsburgh, has resigned, his resignation to take effect on June 30. Mr. S. A. Taylor, C.E., an alumnus of the university, has been appointed dean.

PROFESSOR H. P. BAKER, of the Pennsylvania State College, has accepted a position at Syracuse University as dean of the State College of Forestry, established in 1911 by the New York legislature with an initial appropriation of \$55,000.

PROFESSOR RICHARD S. CURTIS, of the University of Illinois, has resigned to become professor of organic chemistry at the Throop Polytechnic Institute, Pasadena, California, and L. L. Burgess, associate in chemistry, has resigned to become assistant professor of analytical chemistry at the University of Saskatchewan, Canada.

THOMAS C. BROWN, Ph.D. (Columbia, '09), assistant professor of geology in the Pennsylvania State College, has been appointed associate in geology at Bryn Mawr College.

MR. R. J. S. PIGOTT has been appointed assistant professor of steam engineering in Columbia University, a newly established position in the School of Engineering.

H. LEE WARD, of Swarthmore College, has been appointed instructor in chemistry in Wesleyan University.

THE following new appointments to instructorships have been made in the department of chemistry of Columbia University: Andrew Bender, Columbia University; R. H. Lombard, Columbia University; Arthur Edgar, Massachusetts Institute of Technology; Dr. Frederick Barry, Harvard University; R. F. McCrackan, Columbia University; Harry L. Fisher, Cornell Medical School; Robert M. Isham, Columbia University.

PROFESSOR FRIEDRICH CZAPEK, of the University of Prague, has been appointed to the chair of plant physiology and pathology in the Imperial College of Science and Technology, London.

DISCUSSION AND CORRESPONDENCE

A PROTEST AGAINST CHANGING THE INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE

IT is well known to all who have had to deal with questions of nomenclature that much of the confusion in the application of generic names in the past has been due to the lack of system in determining the type of a genus.

It is a matter of small importance just how the type is determined so long as every one uses the same method and the method is sufficiently clear and definite to yield uniform results in the hands of different investigators.

The method of elimination which was for some time in use was unsatisfactory in this respect. It proved impossible to formulate rules by which the type of a composite genus could be "eliminated" by several investigators with the same result.¹

Systematists naturally demanded a simpler method which would give uniform results in the hands of different persons, and the "first species" method met with very general support when the question of a change was raised. The matter came before the International Commission on Zoological Nomenclature at Boston in 1907 and resulted in the adoption, as a compromise, of the method now incorporated in the Code, whereby the action of the first author who designates a type for a polytypic genus is held as binding in all cases where the type is not settled by original designation, tautonymy, etc., as enumerated in Art. 30, rules "a" to "d."

This method is definite and has been accepted by all zoologists who follow the International Code. The types of thousands of genera have been recently determined by this method and many complicated questions of nomenclature have been settled in accordance with its rules. The Commission, with the co-operation of subcommittees, has even begun to prepare lists of authoritative names for genera in various departments of zoology, based upon the rules now in use.

Zoologists began to feel that stability and uniformity were at last in sight—but no! We are recently in receipt of a circular signed by a number of European zoologists advocating a return to the method of elimination and urging that the proposition be brought, not before the Commission on Nomenclature, but before the entire Zoological Congress!

It is hard to see how any zoologist can seriously support such a proposition, especially at the present time, when such satisfactory progress toward stability was being made. It is of course permissible to change the Code of Nomenclature where the rules are obscure or indefinite; but if we are to shift

back and forth to accommodate the views of now one coterie of investigators, now another, we might as well abolish all codes and lapse into nomenclatural chaos.

The return to the elimination method would not only reestablish the chaos in generic names from which we are just emerging, but would undo all the careful work in type determination which has been accomplished in the past five years as well as shake our faith in the permanency of any action of the Commission.

The proposition, moreover, to bring such questions before the entire Congress instead of the Commission on Nomenclature is preposterous. The determination of questions of nomenclature can only be effected by men who have had long experience in this line of work and many members of the Congress who are not systematists have little or nothing to do with nomenclature. For this very reason the Commission was appointed by the Congress and now to propose to ignore it is little short of insult.

One can not but suspect that some of the signers of this petition have been influenced by the entirely erroneous plea that the changes in well-known generic names are all due to the present method of type determination and that the return to elimination would restore the familiar names. Nothing is farther from the truth. Every method of type determination will involve changes in generic names and probably in about equal numbers, but the greatest number of changes is due not to the method type designation nor yet to priority, but to excessive generic subdivision. There would probably be a great protest were it proposed to overthrow the genus *Picus*, the classic name for woodpeckers, but, as a matter of fact, such action would affect the name of but one species of bird, as all other woodpeckers have been removed from this genus!

It is to be hoped that zoologists attending the Zoological Congress at Monaco in 1913 will realize the seriousness of this matter and not permit a technical question of this kind to be taken outside of the Commission on Nomenclature expressly established for its

¹ Cf. SCIENCE, Vol. XXIV., p. 560.

consideration; and further that the members of the Commission will not countenance a change in the Code which is both uncalled for and unnecessary, and which will render void much valuable work and threaten the success of the whole movement toward uniformity in zoological nomenclature.²

WITMER STONE

THE ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA,
May 7, 1912

"GENES" OR "GENS"?

AFTER discussing the significance of the word "phenotype" in *SCIENCE* for April 26, Dr. O. F. Cook states that

Pluralizing the word "gen" is another difficulty encountered by geneticists. Johannsen used the term mostly in its German plural form, *Gene*. Our writers have added another letter making a double plural, "genes," something like "memorandas."

This statement does not correctly represent the origin of the English word "gene" and its plural "genes," now generally used by writers of English papers on genetics. In Darwin's word "pangen" English usage renders the last syllable short, though the two halves of the word contribute equally to its meaning. When the word is transferred to the German, as has been freely done, a law of the German language makes both syllables long. On this account the German word "*Pangen*," better expresses the meaning involved than does the English word "pangen." Johannsen's word "*Gen*," like the last syllable of the German word "*Pangen*," from which it was directly de-

rived, is long in quantity. On transferring this happily chosen word to English it was desired to maintain the long quantity of the German word, and the addition of a final *e*, following a general law of English philology, was made simply for this purpose. The English word "gene" (pronounced *gēn*) is thus seen to bear no direct genetic relation to the German plural "*Gene*," and their likeness in spelling is purely a coincidence. The word "genes" is consequently not a double plural and not at all like "memorandas."

There is a further reason why the word "gene" should be preferred. This word must be used commonly in the plural form, but there is already a word "gens" in rather common literary use and having, at least sometimes, a genetic meaning.

Regarding the definition of "phenotype," few who carefully read the passage translated by Dr. Cook from Johannsen's book will agree with the translator that "phenotype" as used by its author was ever anything but an abstraction. "Centers among series of variations around which the variants are grouped" must always be abstractions, and yet they are, as Johannsen rightly says, "measurable realities." Every individual organism possesses an external appearance and a fundamental constitution, and is therefore a representative of some phenotype and of some genotype. The words "phenotype" and "genotype" were never intended to be limited to *statistically investigated* organisms. Statistical investigation may *discover*, *measure* and *describe* phenotypes, but it does not *create* them. Phenotypes and genotypes exist among Mendelian hybrids just as among all other organisms, and my use of the Mendelian categories to illustrate the proper use of these two words involves no "new version of phenotype."

G. H. SHULL

COLD SPRING HARBOR, L. I.,
April 29, 1912

CRYSTALLOGRAPHIC TABLES

TO THE EDITOR OF *SCIENCE*: The letter of Professor Oliver Bowles, of the University

² Since the above was written I have read Professor Nutting's article in *SCIENCE* criticizing the powers of the commission and the difficulty of bringing a question of nomenclature before the congress for discussion. He fails to realize that these very facts give the code its strength and establish confidence in the permanency of nomenclature based upon it. We do not desire rules that appeal to this man or that, but rules that shall be *permanent* and the International Congress was perfectly right in making it as difficult as possible to change the code.—W. S.

of Minnesota, which appeared in a recent issue of SCIENCE,¹ opens up again the much discussed question of the presentation of the subject of crystallography to undergraduate classes.

Professor Bowles apparently takes the view that the fundamental laws of this science should be studied through their application to concrete examples. It has been the experience of the writer that, in general, the efforts of teachers of crystallography have not been directed with sufficient force to the lucid presentation of these fundamental laws. In spite of the many varieties of models in glass, wood, paper and plaster of Paris, now at the disposal of the modern teacher of this science, his classes often have only a vague notion of:

1. The mechanical relations of the directions of particle-attraction.
2. The all importance of symmetry as a basis of crystallographic study.
3. The application of the above to crystallographic zones.

With regard to Professor Bowles's suggestion respecting tables for determination of axial ratios, the writer desires to point out that the use of such tables must of necessity presuppose the knowledge on the part of the student of which face of the crystal measured represents a unit plane. Taking the axial ratios of a number of common tetragonal minerals such as:

	\hat{c}	$2\hat{c}$	$3\hat{c}$
Apophyllite	1.2515		
Wernerite .....	.4384		1.3052
Zircon .....	.6404	1.2808	
Rutile .....	.6441	1.2882	
Cassiterite .....	.6723	1.3446	
Xenotime .....	.6187	1.2374	

it will be readily seen that for each of these species a pyramid could be selected which would give a resulting axial ratio fairly close to some pyramid of each of the others. In point of fact, in the above series the difference in angle, measured from the prism, between the pyramid corresponding to 1.2374 (lowest value) and 1.3446 (highest value) is only $5\frac{1}{2}^\circ$

¹ SCIENCE, April 12, 1912, pp. 576-577.

—a difference not easy of determination with a contact goniometer in the hands of an inexperienced student. Such instances could be multiplied many times.

In answer to Professor Bowles's first question as to whether tables of axial ratios would be useful as an aid to crystal determination with the reflection goniometer, it has been the writer's experience (and undoubtedly that of every crystallographic investigator) that in 99 cases the name of the species under investigation is known before it is set up for measurement. In the rare and much to be desired hundredth case (that of a new species) the name would obviously not appear in any table.

To the chemical crystallographer, tables of the axial ratios of artificial crystals might be of use could a work of sufficient size to include them all be prepared, but even such a collection of tables would have to be very frequently revised.

H. P. WHITLOCK

DEPARTMENT OF MINERALOGY,
NEW YORK STATE MUSEUM,
ALBANY, N. Y.

TO THE EDITOR OF SCIENCE: If we may judge from the character of most of the text-books on crystallography, Mr. Bowles's suggestion in SCIENCE for April 12, that any phase of this subject should be turned into an "illuminating and interesting exercise" is certainly a novel one. Yet surely the demonstration of the "value of the science as a means of mineral determination" is the ideal way to bring it before the student, so that crystals shall be to him more than, as Goldschmidt has put it,¹ "a feared and hated collection of geometrical figures, of wood, plaster or paste-board, with vertices and edges and bad Greek names, to be immediately forgotten on leaving school, and preferably never heard of again."

The writer has used tables similar to those described by Mr. Bowles for several years; thus far they have been mimeographed and handed around the class, but if elaborated and

¹ *Ann. d. Naturphilos.*, IX., 121.

collected into book form they would certainly be still more serviceable. The inclusion of all known minerals would be a very desirable feature, but the more important ones should be marked by bold-face type.

The necessity for repetition of each species would be in a large measure obviated if a complete discussion of the rules governing the orientation of crystals in general were presented. Even in the tetragonal system two values of c must be given unless the student is first taught to distinguish first from second order pyramids, by relative size of faces, presence of cleavage, direction of striations, etc. And in the more complex systems similar rules can be formulated. In fact, if such rules had only been collected and presented in an authoritative way in some text-book long ago the rather unfortunate confusion in the present usage in orienting even some common crystals—as, for instance, making the long prism-like faces of gypsum the pyramid—might have been avoided.

Yes, by all means, the preparation of such a list of tables should be undertaken. And perhaps it would be worth while to include similar tabulations of some of the physical properties of minerals, such as color, hardness, etc., on a more elaborate scale than those in Dana's text-book, for instance.

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CHANGES OF BODILY FORM IN DESCENDANTS OF
IMMIGRANTS

TO THE EDITOR OF SCIENCE: Four years ago Professor F. Boas, of Columbia University, was intrusted by the U. S. Immigration Commission with an investigation of the bodily characteristics of descendants of immigrants in America. The results of this undertaking were published two years ago in his report entitled "Changes in Bodily Form of Descendants of Immigrants" (Washington, 1910). In this report Dr. Boas questions the generally accepted theory of anthropologists that the form of the head is one of the most unchanging characteristics of human races,

and concludes that it is subject to "far-reaching" changes in type due to the transfer of the races of Europe to American soil.

Last year I wrote a critique of this report entitled "Professor Boas's New Theory of the Form of the Head—A Critical Contribution to School Anthropology,"¹ in which I took the ground that Professor Boas's own figures do not warrant his conclusion that the shape of the head is influenced by a new environment.

In a recent number of SCIENCE² there appeared a reply to my critique. As the general reader can not get a clear conception from this reply either of the nature of Boas's report of 1910 or of the salient points of my criticism of it, I venture to call attention to the following statements:

Professor Boas in his report of 1910 ignores all previous theories of this most complicated problem (see especially pp. 7, 31, 32, 51) and writes as follows:

Children born more than a few years after the arrival of the immigrant parent in America develop in such a way that they differ in type essentially from their foreign-born parents. These differences seem to develop during the earliest childhood and persist throughout life. It seems that every part of the body is influenced in this way; and even the form of the head, which has always been considered as one of the most permanent hereditary features, undergoes considerable changes. . . . The importance of this entirely unexpected result lies in the fact that even those characteristics which modern science has led us to consider as most stable are subject to thorough changes under new environment. (This is quoted in the "Introduction" to the Report.)

The head form, which has always been considered as one of the most stable and permanent characteristics of human races, undergoes far-reaching changes due to the transfer of the races of Europe to American soil (p. 7).

This fact is one of the most suggestive ones discovered in our investigation, because it shows that not even those characteristics of a race which have proved to be most permanent in their old home remain the same under our new surround-

¹Published in the *American Anthropologist*, XIII, 1911, 394-436.

²April 5, 1912, 537-40.

ings; and we are compelled to conclude that when these features of the body change, the whole bodily and mental make-up of the immigrants may change (p. 8).

The influence of American environment upon the descendants of immigrants increases with the time that the immigrants have lived in this country before the birth of their children (p. 9).

The influence of American environment makes itself felt with increasing intensity, according to the time elapsed between the arrival of the mother and the birth of the child (p. 17).

The type of the immigrants changes from year to year, owing to a selection which is dependent upon the economic conditions of our country. This is shown by the fact that after the panic of 1893 a sudden decrease in the general development of immigrants may be observed, which persisted for several years. A similar change seems to have taken place after the panic of 1907. (Here Boas gives his Table VIII. and Fig. 17, which includes stature, length of head, width of head, cephalic index, and width of face—showing the "general deterioration" in the type of immigrants after the panic of 1893; pp. 28-29.)

That there are not only decided changes in the rate of development of immigrants, but there is also a far-reaching change in the type—a change which can not be ascribed to selection or mixture, but which can only be explained as due directly to the influence of environment. This conclusion has been tested, and in many different ways, and seems to be amply proved. It has been stated before that, according to all our experiences, the bodily traits which have been observed undergo a change under American environment belong to those characteristics of the human body which are considered the most stable (p. 32).

A feature that is particularly noticeable is the general drop of all the absolute measurements after the year 1894. An attempt to combine all the material, adult and children, for these years, brings out the sudden drop after 1893 even more clearly, and a similar phenomenon is repeated between the years 1907 and 1909. For this reason I am inclined to believe that the type of immigrants is directly affected by financial panics (p. 39).

It would seem that the effect of American environment takes place almost immediately after the arrival of the parents (p. 43).

I think, therefore, that we are justified in the conclusion that the removal of the east European

Hebrew to America is accompanied by a marked change in type, which does not affect the young child born abroad and growing up in American environment, but which makes itself felt among the children born in America, even a short time after the arrival of the parents in this country. The change of type seems to be very rapid, but the changes continue to increase; so that the descendants of immigrants born a long time after the arrival of the parents in this country differ more from their parents than do those born a short time after arrival of the parents in the United States (p. 52).

In addition to that I may cite also Boas's explanation of his Fig. 17.

The most striking feature of the diagram is the general decrease in all measurements (viz., stature, length of head, width of head, cephalic index, width of face) in the period following the year 1894, which indicates that the arrivals during the period following the panic of 1893 were underdeveloped in every direction. The increase in the cephalic index during the same period does not contradict the data contained in the other curves (i. e., curves for stature, length and width of head, and width of face), because the index is not an absolute measurement, but the ratio between length of head and width of head. A preliminary tabulation of the measurements after 1907 shows a similar decrease to the one noted here. This decrease is perhaps due to the panic of 1907 (p. 29).

I ventured to characterize this theory as "*environmental-economic*"; and then pointed out that it is untenable, because of many biological and methodological inaccuracies. Not desiring to repeat my former discussion here, I refer the reader to my critique in the *American Anthropologist*.³

In this connection I may call attention to a criticism of the same report by the well-known Italian anthropologist, Professor G. Sergi, of the University of Rome, entitled, "The Pretended Change in the Physical Forms of the Descendants of Immigrants in America" (reprint from the *Rivista Italiana di Sociologia*, Jan.-Feb., 1912). He says:

The numerical series, the diagrams, the claims, the seriousness of the New York anthropologist (Boas) lend credit to the conclusions above men-

³ Op. cit., 1911, pp. 394-436.

tioned (viz., Boas's conclusions), to the great surprise of many anthropologists, some of whom have expressed their incredulity. Not having seen any criticism of Boas, but sounds of retraction on the part of Boas himself, I wish to show how the method which he followed is inexact, and why we can place no faith in his surprising conclusions (p. 4).

Professor Sergi confines himself to the cephalic index, but he rightly says that what is true of the form of the head is equally true of the other data. He continues:

If we consider the other physical forms of the descendants of immigrants, our conclusion acquires a wider and more general significance, viz., that no change of human physical characteristics through the influence of environment has been proved. If, as a matter of fact, there is no change in the physical forms of immigrants in America, the process according to which this change must have theoretically come about is an absurd one (p. 10).

The main points of my criticism of Professor Boas's report of 1910 refer not to classification of the cephalic index, but to the *causes* of its changes. The conventional classification of head forms may or may not be irrelevant. My critique did not treat this problem at all; it only recalled to Professor Boas the fact that he uses familiar technical terms such as "type," "longheaded," "short-headed," which everybody knows but which do not agree with his figures or tables. He says:

The east European Hebrew who has a very round head, becomes more long-headed; the south Italian, who in Italy has an exceedingly long head, becomes more short-headed (p. 7); that the long-headed foreign-born Italians become more short-headed in America (p. 51).

In regard to the cephalic index Professor Sergi, after presenting a table on page 7 of his critique, says:

If we examine the averages (media) of the cephalic index, we doubtless find that for those born in America there is a diminution of from one to two units (or a little more) as compared with those born outside of America. It is this which Boas has shown in his numerous tables. But does this diminution in the averages show, as

Boas pretends, a change in the form of the skull of Jews born in America? Apparently, yes, but in reality, no; because the averages are simply the rude expressions of the composition of the series (p. 7).

That Professor Boas's many sweeping conclusions on the form of the head are based on averages only is shown throughout his report (see especially, pp. 8, 43, 9, 12). Dr. Sergi is right in saying:

The series vary in their composition as might be expected and the averages do not give the character of the composition. In fact these would seem to indicate that certain groups are more and others less brachycephalic while the truth is, that some groups contain more brachycephalics (p. 6).

On p. 8 Professor Sergi gives a comparison and concludes that the real result of it is that only the proportions of the classes are altered; and therefore while they exist in different proportions, there still exist dolichocephalics, mesocephalics, brachycephalics and hyperbrachycephalics among those born in America. Therefore this difference of proportion of the classes can not be said to depend on the change of the form of the skull, but upon the paternal and maternal ancestry, the Jews being immigrants from every part of Europe. Boas does not say from which group his subjects come. In other words, they are the children of every European nationality to which the Jews belong (p. 8).

On p. 10 Dr. Sergi says:

But Boas would have us also believe that the children of immigrants who live in America ten years or longer undergo a more distinct and pronounced change, while the parents undergo none whatever. We should then have to suppose that a general change must have been going on in the organism of the immigrants which modified their generative cells, the ova and the spermatozoa, so that in the embryonal and later development the organism of the children appears modified in form. Who can support such a theory? It appears even more absurd inasmuch as it operates in two directions opposed to each other, the brachycephalics seemingly tending toward dolichocephaly (*i. e.*, with the Jews), and the dolichocephalics tending toward brachycephaly (the case of the Sicilians), by virtue—says Boas—of the environment. The change in the generative cells of immigrants would have to follow in two opposite directions, being most rapid (according to Boas) in the immigrants

of any year and a little less rapid in those of ten. . . . Admitting the theory of the inheritance of acquired characteristics as proven, a change would have to appear in the parents after a long stay in the United States, and this change would have to be transmitted to the descendants; *i. e.*, the cephalic, facial and other forms would first change in the parents and would then be transmitted to the children. But this is not the case; according to Boas such a change appears *ex novo* in the children as soon as the parents land in America or have lived here a year or two. This is absurd in theory and as a matter of fact these are not the conditions, as I have shown.

Finally, Dr. Sergi says that one is tempted to ask:

Why should the two types tend toward a common form in America? Is it because one finds there one fixed type, either absolutely dolichocephalic or decidedly brachycephalic? Not even such a justification exists, because America, both with regard to her natives and her immigrants, has always had dolichocephalics, mesocephalics and brachycephalics; hence there is no influence of environment which can tend to fix a single cephalic form in either natives or immigrants (p. 11).

The general reader ought to know these facts. The main purpose of my critique, as well as that of the present discussion, is not to answer but to raise the questions in regard to the causes of changes of the cephalic type. Whatever the *prima facie* explanation may be, the causes of the shape of the head can not be solved by Boas's new theory, because it is, as I showed in my critique, "based rather on a cross-section of the facts than on a genetic interpretation of them. It is only a genetic description and explanation of them that can give a trustworthy basis for a theory." Is it not a fact that in a considerable part of present-day anthropological, psychological and pedagogical writings one is led to think that the most primary phenomena have been examined with mathematical accuracy, when as a matter-of-fact there must have been left out of account numerous accompanying conditions which determined, to a greater or less extent, the results of the problem studied.

The main objection to Professor Boas's new theory of the changes in bodily form of

descendants of immigrants in America is that it finds only one causal relation, viz., that between figures and environment, ignoring all biological and methodological factors. He does that in spite of the most recent attempts of biologists to explain all organic and inorganic changes by the principles of "plural effects" and "the limits of possible oscillations" (see especially Petrunkevitch's "Gedanken über Vererbung," Freiburg, 1904). These modern biologists support their theories also by the logic of mathematics; so, for example, the formula comprising the ellipse, the parabola and the hyperbola (where r and Δ are polar coordinates):

$$r = \frac{ep}{1 - e \cos \Delta}$$

is capable of many solutions and thus creates many possibilities. I believe that Professor Sergi is perfectly warranted in characterizing as "absurd" an anthropological theory which claims that human bodily forms are plastic and can be moulded even during the "first generation" and "a short time after the arrival of parents under new surroundings."

To sum up. As the general reader knows, the form of the head is considered by anthropologists as the most unchanging physical characteristic of the human body, so that the scientists classify the race into a few cephalic types. Professor Boas, on the contrary, makes unwarranted, sweeping conclusions that even the shape of the head undergoes far-reaching changes in type due to the new environment, a new theory which is not justified by his own figures and is not based on scientific methods and on the required technique of experimental physical anthropology.

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April 18, 1912

SCIENTIFIC BOOKS

Pflanzenphysiologie. By W. PALLADIN. Berlin, Julius Springer. 1911. Pp. vi + 310, figs. in text 180. Price M. 9, paper M. 8.

The new plant physiology from the hand of

Dr. W. Palladin possesses a number of somewhat novel features that will be sure to render it interesting to those dealing with the fundamental principles of physiological science. The present German edition is a translation of the sixth Russian edition of the work, with alterations and additions.

The general view-point of the author and the mode of treatment which characterizes his work are well indicated in the first sentence of the introduction, wherein it is pointed out that the aim of plant physiology is to gain a complete and thorough knowledge of all the phenomena occurring in plants and ultimately to interpret these in terms of the principles of physics and chemistry. From this it may be expected, and it is indeed true, that the present work contemplates plant phenomena more from the standpoint of chemistry and physics than does any one of the already existing treatises on plant physiology.

The book before us is divided into two parts, the first (206 pages) on Nutrition and Development. The eight chapter headings of Part I. are as follows: (1) Assimilation of Carbon and of the Energy of Sunshine by Green Plants, (2) Assimilation of Carbon and of Energy by Plants without Chlorophyll, (3) Assimilation of Nitrogen, (4) Absorption of Ash Constituents, (5) Absorption of Materials, (6) Movement of Materials in Plants, (7) Material Transformations in Plants and (8) Fermentation and Respiration. In the fourth chapter heading, logic would require the word *assimilation* instead of *Aufnahme* (absorption) for the latter word occurs, as *Stoffaufnahme*, in the fifth heading and the ash constituents are surely materials. The chapters of Part II. are entitled as follows: (1) General Conceptions of Growth, (2) Growth Phenomena Dependent on Internal Conditions, (3) The Influence of the Environment on Growth and Development, (4) Tendril Climbers and Twiners, (5) Movements of Variation [not due to growth], and (6) Development and Reproduction.

In Part I. the treatment is primarily chemical, and it is in respect to the chemical phe-

nomena of physiology that Palladin's book will prove most useful. In the fifth and sixth chapters, dealing with physical matters, the discussion is not as thorough as in the others. Chapter VI., for example, on the movement of material in the plant, contains no mention of H. H. Dixon's excellent and thoroughgoing study on the ascent of the transpiration stream, although the commonly cited experiments of Böhm and of Askenasy (demonstrating the great cohesion of water and the adhesion between it and mercury) are adequately presented. The discussion of root pressure, exudation and guttation is far less complete than that of many chemical processes of which we have no more adequate knowledge than we have of these, and the theoretical consideration of these fundamental occurrences is dismissed with the mere remark that "the causes upon which these phenomena depend have as yet not been determined" (p. 136). The matter of acid secretion (gland action in general) does not receive attention.

It is interesting to note that the toxic substance theory of soil fertility is given due consideration (p. 98 *et seq.*), and that, in this connection, a figure from a U. S. Bureau of Soils Bulletin and one from Dachnowski's recent studies on the toxicity of bog water are reproduced.

The growth of our general conceptions of respiration and related processes in organisms has recently been evidenced by a gradual bringing of the subject of fermentation into more and more intimate relation with so-called normal respiration. Palladin, once for all, places the whole matter upon a proper logical basis by opening the discussion with fermentation and following with the other topic. This, the reviewer thinks, is a marked advance in logical presentation, and it may do much toward clearing away the haziness which so generally obscures the whole subject of plant respiration.

The first two chapters of Part II. present, in an unusually concise manner, the main principles which underlie growth phenomena in general. The third chapter comprises general

but exceptionally complete discussions of the main relations between growth and the environmental factors. Nevertheless, the treatment of the influence of temperature lacks any mention of the conception of the temperature coefficient of growth activity, the chemical principle of Van't Hoff and Arrhenius as recently applied to physiological phenomena, although the author emphasizes the point that the phenological method of summer temperatures for the growing period can not be expected to give anything but the crudest of indications regarding the temperature relation of plants. It seems that enough has already been accomplished with the Van't Hoff-Arrhenius principle to warrant some treatment in a work of this kind. In the section on the influence of light, Palladin points out, as he has done before in the literature, that many of the developmental phenomena which are usually ascribed to light conditions should rather be referred to those of moisture. "All the characteristics of the development of etiolated plants may be explained by the altered transpiration conditions of these plants and by the resulting correlative influences of the individual organs" (p. 257).

In the last chapter of the book the author very happily presents the modern theory of internal secretions (developed from work with animals) as the basis of the physiological control of growth. "Hormones must doubtless also exist in plants." "The various phenomena of growth and of plant form will surely prove to be dependent upon different hormones" (p. 300). Such predictions, together with the activity of animal physiologists in this direction, can hardly fail to exert an accelerating influence upon the development of plant physiology.

In a general way, as clear and readable a book on this subject has not previously appeared. The style is always simple and nearly always characterized by strict logical sequence. The volume is almost without teleological implications, though the purist on this subject may smile at such an obsolescent section heading as, "The Necessity for the Movement of Materials" (p. 122), and the ex-

position thereof, which indicates that *necessity* here means *need* and not *cause*. Such must be regarded as mere slips into hitherto common and now more or less stereotyped modes of expression frequent in biological literature. The more fundamental principles are developed by the historical method, at once placing before the reader the present status of any given question and the names and methods of the workers to whom that status is due. Citations of literature are numerous, but not too numerous, and the western reader will be gratified in finding here a source for references and digests of some of the more important contributions not commonly cited in German, French and English works of this character.

On the whole, the reviewer is inclined to place Palladin's work at the head of the rather short list of books suitable to be placed in the hands of elementary students of plant physiology.

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Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum. Vol. A, Medical, 404 pp., 23 pls., 118 figs. in text. Vol. B, General Science, 333 pp., 20 pls., 101 figs. in text. ANDREW BALFOUR, M.D., Director. Published for the Department of Education, Sudan Government, Khartoum, by Bailliere, Tindall and Cox, London; Toga Publishing Co., New York City, agents for the United States.

These two highly specialized and elaborately illustrated volumes are filled from cover to cover with the results of research of high order. They are an epitome of the peaceful and effective conquest of the Sudan by the forces of modern science, of biology and chemistry, applied to the problems of the desert and the jungle in the tropics among a people submerged in ignorance and superstition and sunk in racial lethargy. The army of occupation is small, the staff of these laboratories numbering but eleven, including two officers, Captains Archibald and Fry, detailed

from the Egyptian army, and the Arab junior clerk. But the losses are heavy, for peace in the tropics claims its victims no less than war, in fatalities and sick leaves. The heavy loss to the laboratory caused by fire was promptly made good by the patron of the institution and its work has increased greatly in variety and magnitude in recent years.

This is noticeable in the accessions of volunteer helpers, Dr. Stevenson and others, and in applications for opportunity to work in the laboratory far exceed its facilities. The extensive work of this institution is carried up and down the Nile and its tributaries by the ubiquitous laboratory steamer *Culex* and by a floating laboratory equipped for researches remote from Khartoum.

For the first time the term "tropical" is added to the official title of the institution. This is particularly fitting, not only from the location, 15° 30' N., but also because this is the last outpost of civilization at the river gate to tropical Africa. It is also a natural center for the attack upon the problems which inhere in a desert environment and arise when man tames it by irrigation.

The medical volume is in large part devoted to tropical diseases of man, but likewise contains a number of important studies in bacteriology, protozoology, sanitary problems, and in that field of constantly increasing importance, comparative pathology. Lieutenant Colonel Mathias, president of the Sleeping Sickness Commission, reports upon the measures taken to check that great plague by segregation of sick natives in fly-free camps, clearing vegetation at all fords along the automobile road, and the introduction of treatment of the disease by atoxyl, metallic antimony and Ehrlich's "606."

Animal trypanosomiasis of the Sudan are discussed by Captain Fry in a very able manner. He notes that the natural conditions of this country tend to group both animal and human life in isolated colonies and hence to develop apparently isolated types of diseases which alter the virulence and characteristics of the trypanosomes which cause them. He accepts as the most reliable method of dif-

ferentiation the use of frequency polygons based on careful measurements of comparable preparations of the organisms, preferably from similar culture animals. This morphological basis in his opinion is more trustworthy than animal inoculations and reactions, culture, carrier, or the reaction to drugs, as a means of specific distinction.

An endoglobular developmental stage in the red-blood corpuscles similar to that found by Dr. Chagas in Brazil for *Schizotrypanum cruzi* is reported by Mr. Buchanon for *Trypanosoma brucei*. Captain Archibald has discovered human botryomycosis in the Sudan, the occurrence of acid-fast bacilli like *B. tuberculosis* in the lungs of the camel, and a new form of cutaneous leishmaniasis.

The work of the director, in addition to the heavy routine of administration, has included a study of the peculiar "infection granules" of fowl spirochaetosis including the life history of the spirochete in the ticks which serve as vectors. These results have important bearings on African tick fever and other spirochetal infections of man. The specific relations of the spirochete of human tick fever at Khartoum to *Spirochete verbera* of Algiers is definitely established by Dr. Balfour. From his pen also comes a most useful paper on the fallacies and puzzles met with in a blood examination in the tropics and elsewhere, with a colored plate displaying the pitfalls which await the novice who searches for blood parasites, into which forsooth some experienced workers have been entrapped. A coccal form of the diphtheria bacillus is recorded from Khartoum, and Leishman nodules or non-ulcerating "oriental sores" are for the first time described.

An illuminating picture of sanitary administration is afforded in the director's account of "Some Aspects of Tropical Sanitation" in which is revealed not the militant hygiene of Panama, but another type of sanitary tyranny adapted to the life of an ignorant and fanatical people. To wage a successful war against conditions which tend to slay the white man and the black what is required is "education, such legislation as will crush the cul-

tured but ignorant fanatic and aid the worker, a devotion to the cause, and a well-trained band of helpers." In the Sudan where for many years smallpox was a dread calamity, it is now well-nigh as extinct as the dodo. The native is convinced of the beneficent results of Jenner's discovery and the anti-vaccinationist has not yet raised his voice in the desert.

The water supply of towns in the tropics and the bacterial standards to be enforced are discussed at length, with the general conclusion that the conditions are utterly different from those of civilized lands of temperate climates so that the problem of standards must be worked out anew in the tropics. Despite Clemesha's conclusions from analysis in India where soil contamination is great and sewage in streams relatively small, that the use of *Bacillus coli communis* in wider elastic sense as an indicator of contamination of water supplies in the tropics is inadequate and misleading, Dr. Balfour still concludes that this criterion gave useful results in detecting contamination in the municipal supply at Khar-toum.

The second volume, devoted to general science, contains a wider range of articles, from a treatise on municipal engineering in the tropics by members of the staff of Gordon Memorial College, to a treatise on the venom of the spitting snakes of Rhodesia and the Sudan. Here are the reports of the staff chemist, Dr. Wm. Bean, and the entomologist, Dr. H. H. King, the former dealing with soil analysis, gum production, hashish and native poisons, and the latter treating of the insects destructive to crops, mosquito control and the relation of birds to insects. Experiments in exterminating mosquitoes in irrigation ditches by a small minnow of similar habit to "Millions" of the Barbados, known as *Cyprinodon dispar*, have been successful. Other biological papers deal with the mosquitoes, birds and scorpions of the region.

The anthropological interests are represented by an account of the ancient gold mines of the Sudan by Mr. S. C. Dunn, gov-

ernment geologist. The Turin papyrus (14th century B.C.) describes these mines and is accompanied by the oldest maps in existence. The cult of the Nyakang and the divine kings of the Shilluk peoples are investigated by Dr. C. G. Seligmann. The king is killed when old age or sickness threatens. Captain Anderson gives an interesting analysis of the tribal customs in their relation to medicine and morals of the Nyam Nyam and Goor peoples of the upper Sudan.

These two volumes are full of varied information, much of it of great interest and promise of permanent value. It is magnificently suggestive in its portrayal of the warfare of science on the firing line of civilization and full of incentive to the reserves at the rear.

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A History of the Birds of Colorado. By WILLIAM LUTLEY SCLATER, M.A. (Oxon.), M.B.O.U., Hon. M.A.O.U. (lately Director of the Colorado College Museum). With 17 plates and a map. Witherby & Co., 326 High Holborn, London. 1912. 8vo. Pp. xxiv + 576. For United States, \$5. Edition limited to 550 copies.

This is a well-planned and thoroughly up-to-date manual of the birds of Colorado, printed on light-weight paper, and, though a bulky volume of 600 pages, is easy and comfortable to handle. The work is based primarily on the collection of Colorado birds formed by Mr. C. E. Aiken during the last thirty-five years, recently acquired by the late General William J. Palmer and presented by him to the Museum of Colorado College, of which the author of the present book was recently for some years the director.

The introduction deals briefly with the physical features of Colorado, and contains an analysis of its bird fauna, with (1) respect to the season of occurrence of the species and (2) their distribution in the state with respect to altitude. Of the 392 species thus far recorded, about 17 per cent. are resident throughout the year, while the summer resi-

dents form about 30 per cent., the remainder being transient visitors in winter, spring and fall, of which about 106 species are of merely casual occurrence, with only from one to half a dozen records within the state for each.

The nomenclature and classification adopted conform to the third edition of the A. O. U. Checklist, which renders unnecessary the citation of original references for the genera and species. The author has also adopted a concise method of citing the Colorado references under each species, where the name of the author, an abbreviated date and a page reference direct the reader to the full title and place of publication of the paper given in the bibliography near the close of the volume (pp. 532-551), which mentions every publication of importance relating to Colorado ornithology up to December, 1910. This is followed by a gazetteer of the localities specially mentioned (pp. 553-562). With the keys to the higher groups, genera and species, the very satisfactory descriptions, the notes on distribution and habits, the author has succeeded in providing an admirable handbook of Colorado ornithology. Although there are here and there a few minor slips, the work bears the earmarks of a practised hand, and shows a thorough mastery of the subject, although the author's sojourn in Colorado was a comparatively brief one and his personal experience with Colorado birds thus necessarily limited.

The work is dedicated to his friend and patron, the late General Palmer, whose portrait forms the frontispiece of the volume. The half-tone plates illustrate the nesting habits of a number of interesting species, from photographs by well-known Colorado ornithologists. A contour map shows the principal streams, the counties and county-seats of the state, and indicates on a small scale the diversity of altitude and physical features.

J. A. A.

BOTANICAL NOTES

THE GARDEN IN EDUCATION

DORA WILLIAMS has done a good thing in writing a little book on "Gardens and their Meaning" (Ginn), and doing it in such an at-

tractive way that its reading is certain to accomplish what the author desired, namely, "to show the importance of science in the use of spade and hoe, and to urge that a garden for education may be, not merely in substance, but in spirit, a corner of the great world." A serial citation of the headings of the thirteen chapters will develop the topic, while at the same time giving the substance of the author's message. Thus we find headings as follows: What Makes a School Worth While? Little Studies in Cooperation; Situation and Soil; Plotting and Planning; A Word for Good Tools; Planting; The Art of Making Things Grow; Just How; Garden Foes and Garden Friends; Side Shows; New Life in Old Subjects; The Young Farmer's Almanac; The New Agriculture. The reader who knows something of the place of the garden in education can easily fill in most of these chapter headings, but few can do it in such enthusiastic words and such a genuine spirit of helpfulness and hopefulness. Her closing sentence may well be quoted as giving the purpose of the book:

Gardening, then, worked out at school after some such plan as has been sketched in these pages, will be a powerful lever to raise agriculture—rightly viewed the most rewarding of occupations—from the humble plane, where it has long remained, to the heights which it is destined to command.

The book is evidently designed for adults and the older only of the school children. It should be widely read and discussed in the "reading circles," especially those composed of earnest teachers, where it should do much good. One is tempted to suggest that the author should now write a complementary book for the children, a difficult task, but one for which she appears to be well fitted.

AN ISLAND FLORA

ABOUT seven years ago the California Academy of Sciences sent a scientific expedition to the Galapagos Islands (500 to 600 miles west of Ecuador), one of the incidents of which was an eleven days' visit to Cocos Island about midway between Costa Rica and the archipel-

ago. The botanical results of this visit are now published by Alban Stewart, botanist to the expedition,¹ which has just appeared under date of January, 1912.

The island includes between eight to ten square miles and rises often abruptly from the water, culminating in a mountain cone 2,788 feet high, evidently volcanic, but now heavily covered with a dense vegetation. The rainfall is abundant, and the temperature ranges from 68° to 92° F. Near the shore are coconut trees, but no mangroves, "possibly because of the absence of quiet bays and lagoons."

The interior of the island is covered for the most part with rain forests, in which the vegetation is usually so dense that even at midday, with the sun shining, the light is almost as diffuse as at twilight.

The trees are large and tall, reaching a hundred feet or more. "The largest and probably the most important tree from an economic standpoint is one which bears the common name of 'Ironwood'" of which there are trees on the island "so large that timbers $3 \times 3 \times 60$ feet could be cut from them."

In summing up the results of his study of the vegetation of the island the author says:

The flora of Cocos, like that of the Galapagos Islands, is distinctly that of an oceanic island. The relatively large number of ferns, the much smaller number of species in the remaining families, and the total number of species found on the island lend support to this view. The flora is probably of much more recent origin than is that of the Galapagos Islands. . . . It seems possible that the time that has elapsed since conditions on the island were suitable for the growth of higher vegetation has not been sufficient to stock the island by the slow process of seed dissemination, over considerable areas of water, with as many species as it is capable of supporting. The small number of endemic species on the island might also point to a relatively recent origin of its flora.

SYSTEMATIC NOTES

It is a hopeful sign that from time to time Professor Schaffner brings out papers on the

¹ *Proc. Calif. Acad. Sci.*, 4th series, Vol. 1.

classification of plants, the last of which appeared in the *Ohio Naturalist* for December, 1911. In this he reviews and rearranges some of his previous schemes, and adds a synopsis of the phyla, classes and subclasses of the whole vegetable kingdom. In the latter he recognizes fifteen phyla, viz: Schizophyta, Myxophyta, Zygomycota, Gonidiophyta, Phaeophyta, Rhodophyta, Charophyta, Mycophyta, Bryophyta, Ptenophyta, Calamophyta, Lepidophyta, Cycadophyta, Strobilophyta, Anthophyta. The discussion contains a statement of principles, one of which may well be reproduced here:

In a word, the whole scheme of classification must show the result which has come about through progressive evolution, segregation, degradation and specialization.

Another paper by Henry Pittier on "New or Noteworthy Plants from Colombia and Central America," in the *Contrib. U. S. Natl. Herb.*, Vol. 13, pt. 12, among other things contains a revision of the *Artocarpoideae-Olmediae* of the family *Moraceae* which will interest critical systematists. Many good plates and text figures add much to the value of the paper.

In part 1 of Vol. 16 of the same *Contributions*, we find a critical discussion by W. R. Maxon, of the systematic standing of a Rocky Mountain fern known as *Asplenium andrewsii*, which may turn out to be an Americanized form of the European *A. adiantum-nigrum*.

Accompanying the foregoing is a "Report on a Collection of Plants from the Pinacate Region of Sonora," by J. N. Rose and P. C. Standley, in which are given the botanical results of an expedition from the Desert Laboratory at Tucson in 1907, into a region never before visited by a botanical collector. "The botanical collections, although small, have proved to be most interesting." Eighty-four species are enumerated, of which eleven are here described as new to science. Eight of the plants in the list are Monocotyledons, of which seven are grasses. Ten are Cactaceae, while seventeen are Compositae. The fine plates add greatly to the interest of the paper.

Dr. E. L. Greene continues in *Leaflets* (Vol. II., pp. 165-196) the publication of new species from different parts of the country, much space being given to new species of *Apocynum*, of which upwards of forty species are recognized that hitherto have found place under *A. cannabinum* and *A. androsaemifolium*. Half a dozen new species of *Troutvetteria* and five of *Erigeron* complete the fascicle.

Brief notice may be made here of the "Outline Key of the Groups of the Genus *Helianthus* in Michigan," by Mr. S. Alexander, in the Nineteenth Report of the Michigan Academy of Sciences (1911), in which the author brings together for publication some results of his critical studies of these plants in the field and under cultivation. Although incomplete, the paper contains many hints that systematic botanists may well heed.

Dr. A. Nelson's "New Plants from Idaho," in the *Botanical Gazette* for October, 1911, adds a number of new species from southwestern Idaho, a region as yet little known botanically.

Wm. R. Maxon describes (Smithsonian Miscellaneous Collections, Vol. 56, No. 24) "A Remarkable New Fern from Panama," a species of *Polypodium* in which the sori become crowded out so as to appear marginal upon the leaflets. To this species he has given the name *P. podocarpum*, and the hint is thrown out that it may constitute "a distinct generic type."

In M. A. Howe's Phycological Studies, V., in the *Torrey Bulletin* for November, 1911, he publishes a list of nine Chlorophyceae, seven Phaeophyceae, and twelve Rhodophyceae from Lower California, of which eight are new.

From the Institut de Botanique, Université de Genève, the fifth and sixth fascicles (1910, 1911) contain the usual variety of contributions, ranging from morphology to physiology, pathology and the systematic botany of lower and higher plants, as, a new *Rhamnus*, the green snow of an Alpine

glacier (due to *Ankistrodesmus vireti*), the copulation of *Spirogyra*, the physiological rôle of catalase, a new blue-green alga, etc.

The well-known Minnesota Botanical Studies have begun to appear again, the second part of Vol. IV. bearing date of September 15, 1911. Its four articles are "Observations on the Morphology of the Underground Stems of *Symplocarpus* and *Lysichiton*," by C. O. Rosendahl; "Some Effects of Severe Frost upon Vegetation in a Condition of Active Growth," by F. K. Butters and C. O. Rosendahl; "Notes on the Species of *Liagora* and *Galaxaura* of the Central Pacific," by F. K. Butters; "Nova Fungorum Coloradensium Genera," by F. E. Clements, the last including six new genera of Sphaeriaceae. With this part are given title-page, table of contents and index of Volume III.

PATHOLOGICAL NOTES

DR. C. W. EDGERTON'S papers "Two New Fig Diseases" (*Phytopathology*, February, 1911), "Diseases of the Fig Tree and Fruit" (Bull. 126, La. Expt. Station, March, 1911), "The Red Rot of Sugar Cane" (Bull. 133, La. Expt. Station, December, 1911), "*Botryosphaeria* on Cotton Bolls" (*Mycologia*, January, 1912), and "Flower Infection with Cotton Boll Rots" (*Phytopathology*, February, 1912), show that botanical activity in the south is bringing good results.

The same thing is shown by J. R. Johnston's "History and Cause of the Coconut Bud-Rot" (Bull. 228, Bureau of Plant Industry, U. S. Dept. Agric., February, 1912), dealing with "a very destructive and widespread disease of cocoanuts which has been known to occur in Cuba for more than thirty years." The bulletin is the result of investigations in Cuba, Jamaica, Trinidad and British Guiana, covering a period of four years. The remarkable discovery was made that the organism causing this bud-rot is the common *Bacillus coli*, and "it is believed that birds and insects are the carriers of this disease," but to this the author cautiously adds "the subject requires further study."

MYCOLOGICAL NOTES

THREE papers of much more than usual value in such a publication are found in the *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* (Vol. XVI, Part II, No. 4). The first, by E. M. Gilbert, is entitled "Studies on the Tremellineae of Wisconsin" and includes notes upon twenty-one species belonging to nine genera. Apparently this systematic paper is preliminary to "a further physiological and cytological study of the group." The second paper, "Spore Formation in *Geoglossum glabrum* Pers.," by Hallie D. M. Jolivet, is a careful study of the formation of ascospores, with especial reference to the behavior and significance of the rays of the polar aster. Three fine plates accompany the paper. The longest paper is that by B. F. Lutman, entitled "Some Contributions to the Life History and Cytology of the Smuts." In it the author has reinvestigated the spore-formation and germination of species of smuts belonging to the genera *Ustilago*, *Doassansia*, *Urocystis* and *Entyloma* and compared them with *Tilletia* and other well-known genera. He finds that two groups of smuts may be distinguished—"the *Ustilago* group," and "the *Tilletia*, *Entyloma*, *Urocystis* division," which, he says, "may be more distantly related than has been commonly supposed." These he characterizes as follows: (1) *Ustilago* group, "simple spores produced by the breaking up of the mycelium; intercellular mycelium without haustoria; typically four-celled promycelium"; (2) *Tilletia*, *Entyloma*, *Urocystis* group, spores borne on lateral branches; haustoria; binucleated cells and non-septate promycelium. Eight good plates accompany the paper.

PALEOBOTANICAL NOTES

A CONCISE statement of one portion of paleobotany is given by Dr. J. M. Coulter in the February number (1912) of the *Popular Science Monthly*, accompanied by a helpful chart showing the relationships of the Cycadofil-

cales, Cordaitales, Benettitales, Cycadales, Ginkgoales, Coniferales and Gnetales.

The same author and Dr. W. J. S. Land published in the *Botanical Gazette* (June, 1911) a short paper (with two plates) on "An American *Lepidostrobus*" in which the structure of a fragment of a well-preserved cone is described from the central Iowa coal measures. This appears to be the first description of an American *Lepidostrobus* cone.

In a pungent note "On the True Nature of the Cretaceous Plant *Ophioglossum granulatum* Heer." in the *Annals of Botany* (October, 1911) Dr. M. C. Stopes shows that instead of being an *Ophioglossum*, the specimen from the Amboy clays is that of a staminate pine cone, and in proof of this conclusion she figures four pollen grains showing the characteristic wings!

An enumeration of the titles of some of the many papers published in recent years by the well-known paleobotanist G. R. Wieland may be helpful to botanical readers who are interested in this portion of botany, and especially in the method of discovery. Thus in the March, April and May numbers of the *American Journal of Science* for 1889 there appeared, under the general title, "Study of Some American Fossil Cycads," papers on "The Male Flower of Cycadeoidea," "Leaf Structure of Cycadeoidea," and "The Female Fructification of Cycadeoidea," showing that at that time he had made much progress in unraveling the puzzle of the old Cycads. Again later (March, 1900) in his paper on the "Yale Collection of Fossil Cycads" (*Yale Scientific Monthly*) he comes so near to the solution that he finds macrosporangia and microsporangia on the same trunk. Then in a fourth paper under the general title of "Study of Some American Fossil Cycads" he returns again (*Am. Jour. Sci.*, June, 1901) to the microsporangiate fructification of Cycadeoidea, and now makes out the structure of the old Cycad flower with its ovulate central cone surrounded by a whorl of pinnate stamens! Later came "The Proembryo of the Bennettiteae" (*Am. Jour. Sci.*, December, 1904); "Historic Fossil Cycads" (*Am. Jour. Sci.*,

February, 1908); "Paleobotany" (reviews in *Am. Jour. Sci.*, April, 1908); "The *Williamsonias* of the Mixteca Alta" (*Bot. Gaz.*, December, 1909); "Further Notes on Seed Structures" (*Am. Jour. Sci.*, August, 1911); "The Williamsonian Tribe" (*Am. Jour. Sci.*, December, 1911), and "The Smaller Flowerbuds of Cycadeoidea" (*Am. Jour. Sci.*, February, 1912). In the last is ample confirmation of the author's interpretation of the old Cycad flower structure as announced by him nearly eleven years earlier. These papers, with the author's monumental volume, "American Fossil Cycads" (1906) constitute a remarkable example of the gradual uncovering of facts and their successful interpretation, and combination into a consistent phylogenetic scheme.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

THE INEFFICIENCY OF WIRES AS A MEANS OF CURING DEFECTIVE ACOUSTICS OF AUDITORIUMS

In the popular mind, one of the first aids for a hall with poor acoustics is to install a system of wires or strings with the expectation that in some way the defect will be cured. This prevalent idea is doubtless due to the fact that there are many halls where wires have been strung, and people naturally conclude that there must be some merit in the method. As a matter of fact, this popular impression does not seem to be well founded, for the author has inspected a number of halls thus treated, and has found no marked improvement in the acoustics.

Thus in Dr. Parkhurst's church in New York City where a thin network of silk fibers of large mesh was stretched horizontally about half way between the floor and the dome, there still persisted a reverberation and an echo. In the Royal Cathedral in Berlin, a number of silk cords are installed in a horizontal network, yet the acoustics remain very defective. A fishnet is stretched near the ceiling in one of the court rooms of the Berlin Rathaus

with no benefit to the acoustical properties. The Royal Albert Hall in London has a series of wires installed, and, while the acoustics there are improved, other features than wires have unquestionably produced the effect. The warden of a church in Nottingham, England, writes:

Several dodges were tried to overcome the (acoustical) defect, such as stretching wires across the nave.

And so on for other cases that might be cited.

The conclusions of the author in regard to the inefficiency of wires have not always been in accord with the opinions of the auditors in the various halls mentioned. The janitor of Dr. Parkhurst's church, in answer to the question, "Does the net help the acoustics?" replied, "Some says it does, and some says it don't." In the Royal Cathedral in Berlin, according to the attendant's account, the Kaiser thought the wires produced no improvement while the Kaiserin thought they did. The direct question to the attendant as to his own opinion proved very embarrassing and brought only a shrug of the shoulders. Later conversation, however, revealed his conviction that no help had been rendered. In the majority of cases where opinions were asked for, there was a decided expression against the use of wires—"the acoustics are as bad as before," "The wires have not helped," etc.

Some people, however, claim that the method is advantageous, and that the acoustics are really benefited. The author believes these claims are sincere, but attributes the better hearing to other features than the wires. For instance, the acoustics are usually improved when a large audience is present. Also, the opening of windows produces a good effect. Furthermore, regular attendants in a hall with poor acoustics get used to the defect, and, by an adjustment of the attention, are able in some cases to subordinate the disturbing factors and hear better than before. Thus on one occasion the author fixed his attention on a particularly strong echo and was able to hear more distinctly than by listening to the words

as they came directly from the speaker. On another occasion in this same hall the leader of the band had great trouble in conducting a certain selection. The piece being played was a xylophone solo with orchestra accompaniment. After some time the leader discovered that he was beating time to the *echo* of the xylophone. The players near the soloist kept proper time, the others near the leader played in unison with the echo. The result may be imagined.

While both observation and opinion indicate that acoustical defects are not helped by wires, it is interesting to look for further confirmation from the standpoint of theory. It is well known that if a loud tone is sung near a piano, certain wires of the latter will re-sound. Perhaps this phenomenon suggested the use of wires in auditoriums, with the hope that the objectionable sound would be absorbed or broken up in some way. But the conditions for the response of the piano strings are very favorable. There are many wires tuned to different pitches, so that certain ones are in tune, or nearly so, with any tone sung, and these are the wires that re-sound. The wire in the auditorium would respond therefore to only one of the many tones present. To be effective on this score, there would have to be many wires tuned so as to cover a wide range of pitch. Secondly, the piano wire is backed by a sounding board, which absorbs considerable energy and communicates it to the wire. The response is thus very much greater than it would be without the sounding board. The wire in the auditorium has no such sounding board, therefore it absorbs less energy and has less effect on the sound. Finally, the piano occupies a considerable portion of the space of the room and gets energy not only directly, but also by reflection from the near-by walls and ceiling. On the other hand, the wire in the auditorium is small, and is struck by only a small part of the sound waves, direct or reflected, hence has a small chance to help matters. All of these considerations indicate the smallness of the effect to be expected.

One other way in which wires might be beneficial lies in the possible scattering of the

sound waves. Here again, however, the small bulk of the wires allows but little effect. The sound waves pass around the wires in much the same way that large water waves on a pond pass by a stake projecting through the surface. It is only when the obstacle has some size compared with the waves that a disturbance is set up. If there were a large number of wires close together, the sound waves would be influenced. In halls, we find usually only a few wires installed, probably with the idea of having them inconspicuous.

From the various considerations mentioned, it is seen that the installation of wires in halls having poor acoustics is without marked effect. While much remains to be done on the problem of architectural acoustics, and though the means of cure can not be specified readily for each case, it is nevertheless of value to know that the installation of wires, as now used, will *not* serve to cure the trouble.

F. R. WATSON

BERLIN, GERMANY,
March 6, 1912

COLOR VARIATIONS OF THE HOUSE MOUSE IN CALIFORNIA

WHILE trapping for mice in the vicinity of Palo Alto, California, in November, 1910, a mouse was taken the under parts of which were colored white, as in the common Gambel's mouse (*Peromyscus maniculatus gambeli*), but which on examination, proved to be a house mouse (*Mus musculus*). Since that time, trapping in a number of localities in California by the author and others and search through previously made collections of California mammals have brought to light a considerable number of instances of color variations in the house mouse. So far, only a start has been made in the study of these variations. The meager results at hand are published at this time because the author is leaving California. It is hoped that such publication will direct the attention of students and collectors to the house mouse, an animal that is commonly neglected. Very likely further variations will be found in the same animal from other parts of America.

I am indebted to Professor J. O. Snyder, of Stanford University, and to Professor Joseph Grinnell, of the Museum of Vertebrate Zoology, University of California, for suggestions and for the use of the collections under their charge. To Miss Hilda Hempl, of Stanford University, I am indebted for a considerable number of specimens.

The common house mouse is nearly uniform in color all over. The under parts are a little lighter than the back, but the transition is very gradual. The entire color of the mouse is subject to some variation, both individual and geographic. No attempt will be made here to discuss this variation which affects all parts of the mouse equally or nearly so. We will consider only those variations in color which result in one part of the mouse becoming strikingly different in color from the other parts.

A considerable number of house mice in California have the under parts separated in color from the upper parts. The upper parts retain the color of the common house mice of the region, while the under parts become colored either white, creamy buff, reddish buff, or intermediate tints between these colors and the color of the under parts of the unmodified house mouse. These colors of the under parts, where present, are sharply separated from the color of the back and sides at a definite line. In about half the specimens this line is emphasized by the addition of a narrow stripe of pale fulvous.

In all, seven house mice with white under parts, two with creamy buff under parts and a much larger number with reddish buff under parts have been taken up to the present time. Enough intermediate stages between the various colors have been found so that it becomes certain that these grade into one another and therefore are probably the product of the same factor or factors of variation. What these factors are we can make no attempt to consider with the amount of data at hand. All attempts to correlate these color variations with cranial or bodily differences have been fruitless.

One peculiar specimen shows an oval white spot about one half inch long on the middle of the belly. In every other case noted the whole of the under parts are affected alike. The area covered by the modified color—except in this one instance—is just about the same as the area covered by the white in the common white-footed mouse (*Peromyscus maniculatus gambeli*).

The earliest record of any variation in the color of the ventral surface of the house mouse of California is furnished by a specimen in the Stanford University Museum collected April 3, 1893, by J. M. Stowell at Palo Alto. This specimen shows reddish-buff under parts sharply marked off from the color of the back. During November of 1907, Joseph Dixon took two specimens with white underparts and one with creamy buff under parts at Palo Alto. All other records of specimens with peculiar coloration are for the fall of 1910 and the spring of 1911.

A large proportion of the mice showing the color variations on which this article is based have been taken at Palo Alto and Stanford University. Here a few were found on the salt marshes near San Francisco Bay and the rest in the houses and barns at Palo Alto and on the campus of the university. In some houses all the mice seem to be more or less modified in color, though not all in the same way or to the same degree. In other places most of the mice may have the typical house mouse coloration and only a few show any variation. From a lot of fifteen mice taken in two days at Stanford University, only one showed any considerable variation and this one was white on the belly. Nearly half the mice taken in the region show some modification of the color of the underparts. Besides the region about Palo Alto, house mice showing variation in the color of the under parts have been taken during 1911 at Tipton, Tulare County, at Madera, Madera County, and at Pacific Grove, Monterey County. Of two house mice taken at Tipton, one shows a light creamy-buff ventral surface, while the other has the ordinary coloration of the house mouse. Of eleven house mice taken at Madera in a

barn and along the Fresno River, four had the under parts a dusky white sharply marked off from the color of the upperparts. The other seven had either no modification in color or the modification was very slight. Of four house mice examined at Pacific Grove, three showed pale reddish buff underparts and the other showed no modification. Two house mice taken at Pismo, San Luis Obispo County, and about fifty taken at Tracy, San Joaquin County, showed no modification. I know of no record of this color modification outside of the state of California.

Besides the modification of the color of the ventral surface, two specimens of house mice from California show the assumption of the dark longitudinal dorsal stripe described by Allen for *Mus musculus jalapæ*. One of these specimens is from New River, Salton Sea, collected by Frank Stephens, and shows a wide dark dorsal stripe with no modification of the ventral surface. Another house mouse from the same locality taken at the same time does not have any indication of the dorsal stripe. The other specimen of the *jalapæ* type is from Madera, Madera County, and in addition to a narrow dark dorsal stripe, has dusky white underparts sharply marked off from the color of the sides so that the color of both back and belly is modified.

These instances seem to indicate that the house mouse is undergoing modification in some localities, and it may be that important results will be obtained by the study of the progress of this modification.

LEE R. DICE

July, 1911

SOCIETIES AND ACADEMIES

THE SECOND ANNUAL MEETING OF THE PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

THE second annual meeting of the Pacific Association of Scientific Societies was held at Stanford University, Friday and Saturday, April 5 and 6, 1912. Eight of the eleven constituent societies held sessions: Technical Society of the Pacific, the Cordilleran Section of the Geological Society of America, the Seismological Society of America, Pacific Coast Branch of the American Historical

Association, the Pacific Slope Association of Economic Entomologists, Pacific Coast Paleontological Society, Biological Society of the Pacific Coast and the California Section of the American Chemical Society. The other societies were either unable to hold or not desirous of holding sessions at this meeting. With the association met also the San Francisco Section of the American Mathematical Society.

The Astronomical Society of the Pacific was elected to membership in the association. This makes the association represent a membership of over 2,000 persons.

The officers of the executive committee elected for 1912-13 are Otto von Geldern, chairman; George D. Louderback, vice-chairman and J. N. Bowman, secretary-treasurer.

Berkeley was selected as the suggested place for the third annual meeting in 1913; and the suggested time was temporarily placed in the spring of that year—the definite date is to be determined later.

The general session of the association was held on Saturday evening in the chapel of the university. In the absence of President Jordan, Dr. Branner, vice-president, gave the address of welcome. Director William Wallace Campbell, of the Lick Observatory, gave an address on "Recent Studies of the Stellar System." He gave the latest views and theories as based on the observations and work done at Mount Hamilton and elsewhere. Professor Ewald Flügel, of Stanford University, read a paper on "Scientific Lexicography," wherein he traced the lexicographical work from the thirteenth century to the present; he discussed the standards that were used by the Grimm brothers in their work, and which formed the basis of all the later activity in lexicography and raised this subject to the rank of a science. Professor Andrew Cowper Lawson, of the University of California, gave the last address of the session on "Recent Views on the Archæan Rocks of Canada." Twenty years ago he examined these rocks for the Canadian government. Lately his findings and views have been brought into question. Last summer he went over the field again, at the instance of the Canadian government, with the result that he is led to corroborate his former findings and views.

J. N. BOWMAN,
Secretary.

BERKELEY, CAL.,
April, 1912

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THE BUILDING OF "CORAL" REEFS

A coral reef is a ridge or mound of limestone, the upper surface of which lies or lay at the time of its formation, near the level of the sea, and is predominantly composed of calcium carbonate secreted by organisms, of which the most important are corals.

THE above is the opening sentence of an able and suggestive paper by Dr. Thomas Wayland Vaughan on "Physical Conditions under which Paleozoic Coral Reefs were formed," published last year in the *Bulletin of the Geological Society of America*.¹ If we pass over for the moment the question as to just what is meant by "near the level of the sea," a point that is discussed by Dr. Vaughan later on, the part of the above definition that particularly challenges attention is the final clause, "of which the most important are corals." It is not to be denied that this last statement embodies the long-standing and still prevalent view as to the origin and composition of coral reefs and, in fact, it might seem at first sight to be quite axiomatic that corals should be the most important constructive agents in the formation of "coral" reefs. But in view of the fact that some rather recent studies indicate that lime-secreting plants have been much more important than the corals in the formation of certain "true coral reefs" and in view of the few borings and analytical studies of so-called "coral" reefs thus far made, there would seem to be sufficient ground for contending that the whole question as to the relative general importance of lime-secreting animals and lime-secreting plants in the formation of reefs is still an open one. From

¹ Vol. 22, p. 238.

what may be observed to-day in the tropics as to the relative abundance of calcareous marine plants and calcareous marine animals and from what has been determined by the study of the cores obtained by boring into coral reefs, it would appear that sometimes the plants predominate and sometimes the animals. As Dr. Vaughan points out, there are good grounds for believing that the conditions attending the formation of coral reefs in ancient times were not very different from those that prevail at present. In any event, the definition quoted above is intended to be a general one and its validity is to be tested by application to recent and modern conditions as well as to those of long-past geological ages.

The best-known example of a thorough and detailed study of the nature of a coral reef is embodied in a quarto work of more than four hundred pages published by the Royal Society of London in 1904 and entitled "The Atoll of Funafuti: Borings into a Coral Reef and its Results: Being the Report of the Coral Reef Committee of the Royal Society." Funafuti was selected for this study because it was considered a "typical" coral reef or island. Several borings were made by members of the three successive expeditions that visited the atoll, the first attempts being only partially successful, and the cores thus obtained were brought back to England for careful study. The main boring was finally driven down to a depth of 1,114½ feet. *Lithothamnion*, a hard stone-like red coral-line seaweed, of the group commonly known to zoologists and geologists as "nullipores," was found to be more or less abundant through the entire length of the boring; *Halimeda*, a calcified green seaweed, was locally very abundant from 28 to 1,096 feet in depth. Professor J. W.

Judd sums up the general results of the analysis of the cores as follows:

Dr. Hinde's carefully drawn up lists show that from top to bottom the same organisms occur, sometimes plants, sometimes foraminifera, and sometimes corals predominating (p. 174).

It is to be observed that he mentions plants first. Moreover, Mr. A. E. Finckh, who was one of the members of the expedition and wrote the chapter on "Biology of Reef-forming Organisms at Funafuti Atoll," definitely groups these organisms in order of their reef-building importance as follows: "(1) *Lithothamnion*; (2) *Halimeda*; (3) the Foraminifera; (4) the Corals." It will be noted that the first two places in this ranking are given to members of the plant kingdom and that the corals, the "most important" reef-building organisms of Vaughan's definition and of the still prevalent popular belief, are relegated to a fourth position. This naturally raises the somewhat academic, though chiefly biologic, question, "When is a 'true coral reef' not a coral reef?" It raises also a serious question as to whether the continued use of "coral" reef for structures that have been built up largely through the agency of plants is not responsible for false ideas and widespread mental confusion.

That the opinion of Mr. Finckh in regard to Funafuti is not his alone, is evident from the following statement by J. Stanley Gardiner, who, being a professor of zoology in Cambridge University, should be free from any suspicion of bias in favor of the plants:

The reef [of Funafuti] seems to have been mainly formed by the growth of nullipores, which are now building up masses outside the rim and adding them on the reef, causing its extension seawards.²

²"The Coral Reefs of Funafuti, Rotuma and Fiji, together with some Notes on the Structure

Incidentally, for the benefit of botanists, who have long abandoned the term "nullipore," even though the enforcement of priority principles in nomenclature may possibly lead to its revival, it may be explained that the generic name *Nullipora*, as proposed by Lamarck in 1801, was made to include four species of calcareous organisms believed by him to be animals, but all of which, probably, were plants and members of the family Corallinaceæ of the red algæ—the family popularly known as the "coralline seaweeds." Furthermore, they were of the subgroup sometimes spoken of as the "unsegmented" corallines, including the numerous forms that until recently have passed under the widely inclusive generic name *Lithothamnion*, but now commonly segregated into smaller generic groups known as *Lithothamnion*, *Lithophyllum*, *Goniolithon*, *Phymatolithon*, etc. But the term "nullipore," which has remained the almost exclusive possession of the zoologists and geologists, while applied chiefly and properly to the stone-like or coral-like red algæ, has occasionally been made to cover also undoubted animals and was used by Alexander Agassiz³ to include also some of the very different calcified green algæ. Alexander Agassiz, by the way, was one of the first to emphasize the importance of "nullipores" in reef-building, but the loose way in which he frequently referred to "nullipores and algæ," "corallines and algæ" may easily have hidden from many of his non-botanical readers the fact that his "nullipores" and "corallines" were just as truly algæ as are any of the species of *Fucus*.

But, to return to our main subject, there is considerable evidence that the dominance

and Formation of Coral Reefs in General," *Proc. Camb. Philos. Soc.*, Vol. 9, pp. 417-503, 1898.

³ *Bull. Mus. Comp. Zool. Harv. Coll.*, Vol. 14, p. 82, 1888.

of plants in building up the "true coral island" Funafuti is not an exceptional or isolated instance of their activity in this direction. Professor Gardiner, in describing the reefs of Fiji, in the paper referred to above, says:

The parts of "compact homogeneous texture" are very numerous and are formed, I believe, mainly by carbonate of lime secreted by incrusting nullipores. The importance of the incrusting nullipores, in the formation of the reefs of the Central Pacific can not be overestimated.⁴

Again,⁵ in discussing the foundation of atolls in general, Professor Gardiner remarks that

The chief building organism is *Lithothamnion*, the bathymetrical zone of which must be limited to a large degree by the extent to which light can penetrate seawater.

In another case,

This nullipore [*Lithophyllum craspedium*], Finckh says, is actually the reef-former at Onoatua [Gilbert Islands]. He saw no live coral there, but everywhere on the lagoon and ocean-face immense masses of this particular nullipore.⁶

That lime-secreting plants rather than corals are sometimes, at least, the dominant reef-formers in the Indian Ocean as well as the Pacific, is shown by the following remark by Professor Gardiner:

The reefs of the Chagos are in no way peculiar, save in their extraordinary paucity of animal life. . . . However, this barrenness is amply compensated for by the enormous quantity of nullipores (*Lithothamnion*, etc.) incrusting, massive, mammillated, columnar and branching. The outgrowing seaward edges of the reefs are practically formed by their growths and it is not too much to say that, were it not for the abundance and large masses of these organisms, there would be no atolls with surface reefs in the Chagos.⁷

⁴ *Loc. cit.*, p. 477.

⁵ *Loc. cit.*, p. 501.

⁶ "Fauna and Geography of the Maldives and Laccadive Archipelagoes," Vol. I., p. 462.

⁷ *Trans. Linn. Soc. London, Zool.*, 2d ser., Vol. 12, pp. 177, 178, 1907. Also, *Nature*, Vol. 72, pp. 571, 572, where a photograph of this *Lithothamnion* reef is published.

That the coralline algæ form extensive banks and reefs in the Dutch East Indies also is indicated by the following quotation from Mme. A. Weber-van Bosse's report on "The Corallinaceæ of the Siboga Expedition":⁸

Near the coast of Haingsisi, an island near the S. W. point of Timor, the Siboga anchored twice . . . ; the second time good luck favoured us, it was springtide, the water sank very low and we could observe that the whole reef . . . consisted chiefly of *Lithothamnion erubescens* f. *Haingsisiana*. It was remarkable that the branching knolls remained quite dry during several hours of the day, exposed to the glare of the tropical sun, and that this seemed not to injure them. . . . This *Lithothamnion*-bank struck me, because it is such a unique sight to see the ground, as far as the eye can reach, covered by the pretty beautifully pink-coloured knolls, which are heaped up so close together that, while walking, one crushes them continually, making a peculiar noise as of broken china. We encountered, however, other and perhaps more instructive *Lithothamnion* banks during our voyage.

Bermuda, as is generally known, was commonly considered a "true coral" island until the studies of Alexander Agassiz⁹ and of Henry B. Bigelow¹⁰ indicated that the corals have played a rather minor part in its upbuilding. Dr. Bigelow believes (*loc. cit.*, p. 582) that "algæ probably form the greatest mass" of what he terms the "shell sands" of Bermuda, and it is of interest to note that Sir John Murray in reporting the results of the *Challenger* Expedition intimates that the calcareous seaweeds and their broken down fragments were the dominating elements in three out of four analyzed samples of so-called "coral" sand or mud from Ber-

⁸"Siboga-Expeditie," Monographie LXI., p. 4, 1904. Interesting photographs of the *Lithothamnion* bank are here published.

⁹*Bull. Mus. Comp. Zool. Harvard Coll.*, Vol. 26, pp. 205-281, 1895.

¹⁰*Proc. Am. Acad. Arts and Sci.*, Vol. 40, pp. 557-592, 744, 1905.

muda. Dr. Bigelow, in connection with his critical studies of "The Shoal-water Deposits of the Bermuda Banks," made a series of dredgings on the *Challenger* Bank, nine miles or more from Bermuda. His dredge brought up chiefly "calcareous pebbles," which on examination proved to be formed by a species of *Lithothamnion*. These were growing at a depth of from 30-50 fathoms, a depth too great for most of the corals. In summing up the results of these studies, Dr. Bigelow writes:¹¹

The dredgings from the *Challenger* Bank add to the evidence already accumulated to prove the great importance of the nullipores as reef builders. . . . This process taking place over the *Challenger* Bank, where there is no direct evidence of either elevation or subsidence, has raised it to within some thirty to fifty fathoms of the surface of the sea, a depth where a few corals already flourish. If we imagine this process as continuing until the bank rises to within about twenty fathoms of the surface, we should then have excellent conditions for the formation of a coral reef. Of course in such upbuilding the nullipores constitute only a part, though a most important one, of the whole growth.

It would appear from this observation of Dr. Bigelow's and from various other records that the lime-secreting seaweeds flourish and are effective reef-builders in greater depths than is the case with the corals. Dr. Vaughan, in the paper under discussion, quotes Professor J. Stanley Gardiner as authority for the statement that the "nullipores extend to a depth of 35 fathoms" in the Maldives, but Mr. A. E. Finekh in his dredging operations about Funafuti frequently found them in "depths of over 100 fathoms *in situ*"¹² and also found *Halimeda* alive down to 45 fathoms. From Alexander Agassiz's description of the Pourtales Plateau off the southern coast of Florida, one seems justified in inferring that he found incrusting

¹¹*Loc. cit.*, pp. 589, 590.

¹²"The Atoll of Funafuti," p. 134.

"nullipores" in a living condition at depths of from 250 to 350 fathoms.¹³ According to Dr. Vaughan, it is generally conceded "that 25 fathoms is the greatest depth" at which the reef-building corals work effectively, "although an occasional reef species may extend downward to a depth of 40 fathoms."

Besides flourishing in greater depths than the corals, the lime-secreting seaweeds are much less dependent upon high temperatures than are the corals. Sir John Murray has remarked¹⁴ that "in the polar seas and in the cold water of the deep seas there is, as is well known, a feeble development of all carbonate of lime structures in marine organisms," a statement that may be true enough in a comparative way for organic nature as a whole, but is manifestly much more true of the corals than of the coral-like red algæ. The coral-line algæ are, locally at least, abundant from 73½° south latitude¹⁵ to 79° 56' north latitude.¹⁶ The late Professor Kjellman, of Upsala, has stated¹⁷ that off the coasts of Spitzbergen and Nova Zembla *Lithothamnion glaciale* "covers the bottom in deep layers for several miles" mostly in 10 to 20 fathoms of water, and he adds that "in the formation of future strata of the earth's crust in these regions it must become of essential importance." Another species of *Lithothamnion* is said to form banks on the coasts of Iceland and of Greenland. Foslie¹⁸ states also that

¹³ *Bull. Mus. Comp. Zool. Harvard Coll.*, Vol. 14, p. 287, 1888.

¹⁴ *Natural Science*, Vol. 11, p. 26, 1897.

¹⁵ Foslie, M., "Corallinaceæ, in National Antarctic Expedition, *Natural History*," Vol. 3, 1907.

¹⁶ Kjellman, F. R., "The Algæ of the Arctic Sea," *Kongl. Sv. Vet.-Akad. Handl.*, Vol. 20, No. 5, p. 96, 1883.

¹⁷ Kjellman, *loc. cit.*

¹⁸ In Gardiner, "The Fauna and Geography of the Maldiv and Laccadive Archipelagoes," Vol. 1, p. 462.

North of the polar circle on the coast of Norway banks have been met with which cover the bottom for several miles and plants appear in immense masses, frequently representing only one species.

A good account of "Algæ as Rock-building Organisms," with special reference to their occurrence in ancient limestones, was contributed to *Science Progress*¹⁹ in 1894 by Professor A. C. Seward, of Cambridge University. An interesting feature of Professor Seward's paper is his summary of the results of J. Walther's studies of a *Lithothamnion* bank in the Bay of Naples about 30 m. below the surface of the water:

By action of the percolating water the *Lithothamnion* structure is gradually obliterated, and the calcareous mass becomes a structureless limestone. Walther applies his knowledge of this recent algal deposit to the examination of a Tertiary "Nulliporenkalk" near Syracuse. In many parts of this formation there occur well-preserved specimens of *Lithothamnion*, but in others a gradual obliteration is observed of all plant structures until the rock becomes entirely structureless. A similar instance of structureless limestone is described from the Lias of Todten Gebirges [Todten Gebirge].

In Bermuda, southern Florida and the West Indies one finds among the living reef-building organisms and in their distribution and association many of the general types described by Gardiner and others for the Pacific and Indian oceans, even though "true atolls" of the Pacific type may be rare or quite wanting. There are banks and reefs that appear to consist almost wholly of calcareous plants others that are almost "pure stands" of corals, and yet others where these two elements are intermingled. In the last case, the "nullipores" often seem to be overgrowing and smothering the corals, as has been observed in the Pacific and elsewhere. In view of all of the evidence now available it would be a bold man who would venture to say

¹⁹ Vol. 2, pp. 10-26.

that the corals are secreting and depositing any more calcium carbonate in the West Indian region than are the calcareous algæ. The massive beds of *Halimeda opuntia* off the Florida Keys (the same species, by the way, that is filling the lagoons of some of the South Sea atolls) are striking, as are the banks of *Goniolithon strictum* in the Bahamas and reefs of *Lithophyllum Antillarum* and *Lithophyllum daedaleum* along the shores of Porto Rico, yet probably none of these are so conspicuous and massive as are certain local aggregations of living corals in the same general regions. However, the lime-secreting plants appear to be much more generally and widely distributed, both horizontally and vertically, than are the corals, and the rate of growth is, of course, a factor of importance in any attempt to estimate the relative lime-depositing activity of corals and calcareous algæ. The notable studies and measurements of living corals by Dr. Vaughan at the Tortugas station of the Department of Marine Biology of the Carnegie Institution of Washington are beginning to throw a most welcome light on the rate of growth of the corals. No similar records of the rate of growth of the calcareous red algæ have as yet been published, so far as we are aware, but from the fact that these plants often cover and smother living corals one is perhaps justified in assuming that the growth of certain kinds of coralline algæ is superficially, at least, more rapid than that of certain kinds of corals. For the rate of growth of the calcareous green algæ we have scarcely any definite records except one by Finckh,²⁰ who observed in Funafuti a radio-vertical growth of three inches in six weeks in a tangle of *Halimeda opuntia* that had found its way through a hole in a board. This growth-rate, which is possibly more than a fair general average for the

²⁰ "The Atoll of Funafuti," p. 146.

species, seems much more rapid than any thus far attributed to the corals.

With the dominance in reef-building activities resting sometimes with the calcareous algæ and sometimes with the corals, and with the Foraminifera and other groups also playing their parts, the problem of determining the "most important" constructive element in the calcium carbonate reefs of the world, ancient and modern, is naturally a most complicated and difficult one and one that may never be solved to the full satisfaction of those most interested. Alexander Agassiz, in 1894, in summing up the general result of his explorations of Bermuda and the Bahamas, which had revealed a condition of things not realized before, frankly remarked that it was a "significant example of how little we as yet know of the history of the formation of the coral reefs."²¹ As a general proposition this remark seems almost as apt now as when it was made in 1894. However, since the day of the first illuminating borings into the "true coral atoll" of Funafuti, much evidence has accumulated tending to show that the importance of the corals in reef-building has been much over-estimated and that the final honors in this connection may yet go to the more humble lime-secreting plants.

MARSHALL A. HOWE

NEW YORK BOTANICAL GARDEN

UNIVERSITY CONTROL

II

IN a review of the different factors concerned with the administration of a university the corporation in ultimate control is the natural starting-point. It was becoming that the fellows of Yale College, a collegiate school primarily for the education of the clergy, should be representative

²¹ *Bull. Mus. Comp. Zool. Harvard Coll.*, Vol. 26, p. 278.

clergymen of the state. In general the trustees of the primitive American college were competent to administer its simple economy. But even then there were difficulties. Before the American Institute of Instruction meeting in Worcester, Mass., in 1837, the Rev. Jasper Adams, president of Charleston College, gave a lecture on "The relations subsisting between the board of trustees and the faculty of the university," stating that as far as he knew this had never been the subject of special investigation. He argues that the trustees should manage the funds of their institution, while the faculty should regulate the courses of instruction and the internal administration. Professors should be appointed by the trustees on the advice of and in accordance with the wishes of the faculty. It appears that in those days there was trouble through the trustees interfering with what the faculties regarded as their rights, notably at Hamilton College, concerning which the president wrote a pamphlet entitled "A Narrative of the Embarrassments and Decline of Hamilton College," which he attributed to meddling by the trustees with the business of the faculty. At that time President Adams and President Davis seem to have regarded themselves as professors rather than as trustees. According to President Adams:

More than one board of trustees has ruined, and every board will ruin its college, which shall interfere with the province rendered appropriate to the faculty by the peculiar skill, knowledge and experience which their education, greater attention to the subject, and practical opportunities, have naturally, and as a matter of course, given them. . . . Many a faculty of a college, who felt themselves qualified, not only to sustain their institution, but to raise it to usefulness and renown, and gain for it the favor, confidence and patronage of the public, have found all their efforts discouraged, embarrassed and finally defeated by the conduct of their board of trustees. Plans of improvement, after having been matured by much

labor and careful consideration, have been presented for acceptance and approbation, only to be retained with coldness and indifference, treated with neglect and finally rejected, after a hasty examination, for want of a competency to understand them. Favorable times and seasons have been permitted to pass by unimproved, and have been lost never to return, because the faculty had not power to act on the subject, and the trustees could not be induced to seize the favorable moment, and turn the occasion to the benefit of the institution. Under these circumstances, the faculty have been compelled to remain inactive, and let things take their course, or to resign their office in discouragement and disgust. In either case, the institution has been ruined.

The legal powers of trustees and regents are similar everywhere, but their actual part in the conduct of the institution varies greatly. It is likely to be larger when the board is small and when the members reside near by. In his Harris lectures on "University Administration" President Eliot says: "The best number of members for a university's principal board is seven," and with pleasing naïveté he adds a little later: "It is a curious fact that the university with the most fortunate organization in the country is the oldest university, the principal governing board, the President and Fellows of Harvard College, consisting of seven men." When the board of trustees is large and meets but rarely, there is usually an executive committee which with the president is in substantial control. The members of this committee are likely to be the friends and adherents of the president—in practise the president is likely to select the trustees and the members of their executive committee—and the faculties and professors are supposed to communicate with the trustees only through the president. Under our existing system, there should be an elected committee of the faculties which would meet with the executive committee of the trustees. It would in addition be advis-

able to permit the professors and other officers to elect for limited terms representatives—not necessarily from among themselves—on the board of trustees in the manner now becoming usual for alumni representation. It is undesirable for the individual professor to tease the trustees with his needs or grievances; but there should surely be some way by which trustees and professors can consider together the problems confronting the university. A joint committee of trustees and professors such as has just now been constituted to administer the Crocker Cancer Research Fund of Columbia University is an excellent plan.

If trustees are trustees and not directors, it does not greatly matter in practise how many of them there are or how they are chosen, so long as they are men of integrity and honor, representative of the common sense of the community. Even if the trusteeship is an acknowledgment of gifts made or hoped for, no great harm is done. But a self-perpetuating board with absolute powers, even though for a generation the powers may not be abused or even used, is intolerable in a democratic community. The president and directors of industrial corporations are elected by the shareholders and are increasingly supervised by the state. In the state universities the regents are elected by the people or appointed by their representatives, and the people may be regarded as the ultimate corporation. In the case of the private universities, it would apparently be wise to have a large corporation consisting of the professors and other officers of the university, the alumni who maintain their interest in the institution and members of the community who ally themselves with it. This corporation—or perhaps better the three groups of which it is composed—should elect the trustees. Thus there might be a board of

nine trustees, one being elected annually for a three-year period by each of the three divisions of the corporation.

Several of my correspondents hold that the members of the community permitted to join the corporation of a university should be carefully selected. I should myself like to see the widest possible participation. If 10,000 or 50,000 people would join such a corporation, so much the better. They would pay dues, perhaps five or ten dollars a year, and would enjoy certain privileges such as attendance at lectures and concerts, the use of libraries, museums, rooms for meetings and the like. If many people are concerned with their university, it is well for them and for it. Some of them will become seriously interested, ready to aid with their counsel, their influence and their money. In New York City several institutions—the Metropolitan Museum of Art, the American Museum of Natural History, the Zoological Park, the Botanical Garden—are partly supported by the city, partly by boards of trustees and partly by members. The buildings are owned and the curators are paid by the city; the collections are owned and the research work is paid for by the trustees; the members have certain privileges in return for dues. In spite of obvious difficulties, the plan has worked well.

A large corporation holding the university in trust for all the people is clearly a step in the direction of public ownership. It is the ultimate fate of every corporation to be controlled by the state, and our private universities will surely become part of the system of public education. This should develop gradually rather than through such measures as have been required to obtain control of church property in other nations. When the people own their universities they will probably see the wisdom of delegating to those con-

cerned—namely, the officers of the university, its alumni and members of the community taking an interest in higher education and having knowledge of it—the right to elect the trustees. True democracy does not consist of government by the uninformed, but of government by those most competent, selected by and responsible to the people. In one of the leading state universities one third of the trustees are elected by the alumni; a second third might to advantage be elected by the teachers, the remaining third being elected by the people or their representatives.

When trustees in the state universities are elected by the people or their representatives and in the private universities are elected by the corporation consisting of officers of the university, alumni and members of the community, the question as to their powers and duties is perplexing. Much can be said in favor of giving them no more power than is vested in a trust company designated as trustee of an estate, and arguments can be urged in favor of a small paid board of experts having the ultimate decision on all questions. I seem to have been almost the only educational person in the country who approved of the principle of Mayor Gaynor's plan for a small paid board of education for New York City, and I should regard its present adoption as risky. This, however, is the correct method of democracy—experts selected by the people and paid for their work. The professors and other officers of the university should be such. Whether in addition to them it is desirable or necessary to have a board to coordinate and control their work, to regulate their duties and fix their salaries, is a question which can only be settled by experience. Certainly the commission form of government is preferable to an individual autocrat.

In the academic jungle the president is my black beast. I may seem to be in the condition of the animal suffering from the complication of diseases described in a recent issue of a New England paper:

Patrolman Lindstrum went to East Elm Street recently and shot an alleged mad dog. The dog also was declared to have hydrophobia and rabies.

As a matter of fact neither barking nor biting is warranted. An eminent philosopher of Harvard University in a lecture to a class at Radcliffe is alleged to have depicted in eloquent terms the darkness of the life of him who has lost his religious faith and then to have added that the only compensation is a sense of humor. Whereat first one and then another of the students began to weep until all the eighty girls were in tears. It is more becoming for university professors to appreciate the semi-humorous absurdity of the situation than to fall to weeping together. I once incited one of my children to call her doll Mr. President, on the esoteric ground that he would lie in any position in which he was placed. Of course, the president is by nature as truthful, honorable and kind as the rest of us, and is likely to have more ability or enterprise, or both. But he really finds himself in an impossible situation. His despotism is only tempered by resignation; and in the meanwhile he must act as though he were a statue of himself erected by public subscription. In Tennyson's words:

Who should be king save him who makes us free.

The argument for giving a free hand to the president is that this is the way to get things done. It should, however, be remembered that it is quite as important—and this holds especially in the university—not to do the wrong thing as it is to do the right thing. The time of the president is largely occupied with trying to correct or to explain the mistakes he has made, and the time of the professor is too much

taken up with trying to dissuade the president from doing unwise things or in making the best of them after they have been done. Administrative details should be attended to promptly and correctly; this is the proper business of secretaries and clerks. Then we need leaders, most of all in a democracy. But in a democracy leaders are the men we follow, not the men who drive us. In the university each should lead in accordance with his ability and character.

The trouble in the case of the university president is that he is not a leader, but a boss. He is selected by and is responsible to a body practically outside the university, which in the private corporations is responsible to nobody. In our political organization, the mayor, governor or president has great power, too great in my opinion, if only because it demoralizes the legislature; but they are responsible to the people who elect them. I object even more to the irresponsibility of the university president than to his excessive powers. The demoralization that the president works in the university is not limited to his own office; it has given us the department-store system, the existing exhibit of sub-bosses—deans, heads of departments, presidential committees, professors appointed by, with salaries determined by, and on occasion dismissed by, the president, all subject to him and dependent on his favor.

It is not my wish to depreciate unfairly the services of the American university president. Like the promoter in business and the boss in politics, he has doubtless been a factor natural and perhaps desirable in a given stage of evolution, when the growth of the complexity of society and the need of new adjustments have outrun the adaptability of the individual. It is probable that the president has increased appropri-

ations and gifts; it is possible that he has promoted rather than hindered the development of the university and the extension of its work. The president, however, has not usually been the cause of gifts, professors and students, but only the means of diverting them from one institution to another, and on occasion of doing so in ways unworthy of the institution which he then misrepresents. The president has not infrequently sacrificed education to the fancied advantage of his own institution. Thus college entrance requirements have imposed studies in the high school which drive from it the majority of boys. The opposition of certain presidents of proprietary universities to a national university is not less pernicious, if it results from honest prejudice. The prestige of the president is due to the growth of the university, not conversely. He is like the icon carried with the Russian army and credited with its victories. President Eliot claimed that he had never asked for a gift for Harvard. During the lean years he was regarded as a poor money-getter; when the fat years came with the increasing wealth of the alumni and of the country, this opinion was reversed, but he had not changed. President Eliot is a truly great man, but his remarks on all sorts of subjects, usually wise but occasionally otherwise, were reported everywhere, not for their wisdom, but on account of his position.

While I regard it as desirable to do what little I can to make ridiculous an institution which has become a nuisance, and while I should find my state of dependence on a president for my opportunity to serve the university intolerable if I concealed my views, I certainly do not wish to be understood as lacking in appreciation of the fine characters and high motives of most of the men who have served

as professors and later become presidents. They do not considerably, if at all, excel in character or ability beyond the average standard of the professorship, but they exploit before the world how high this standard is. The practise of many presidents is a sacrifice of their real convictions to the imagined exigencies of the situation. Most of them would agree that autocracy in the university is undesirable. Thus President Eliot writes:

The president of a university should never exercise an autocratic or one-man power. He should be often an inventing and animating force, and often a leader; but not a ruler or autocrat. His success will be due more to powers of exposition and persuasion combined with persistent industry, than to any force of will or habit of command. Indeed, one-man power is always objectionable in a university, whether lodged in president, secretary of the trustees, dean or head of department.

Dr. Seelye, then president of Smith College, at the inauguration of Dr. Rhees as president of Rochester University, said:

Autocracy, however, is a hazardous expedient, and is likely to prove ultimately as pernicious in a college as it is in a state. It induces too great reliance upon the distinctive characteristics of a despot, and too little upon those of a gentleman. One-man power is apt to enfeeble or to alienate those who are subject to it. . . . Successful autocrats are few, and however long their term of service, it is short compared with the life of an institution. If they leave as an inheritance a spirit which has suppressed free inquiry, and which has made it difficult to secure and retain teachers of strong personality, the loss will probably be greater than any apparent gain which may have come through the rapid achievements of a Napoleonic policy.

Under existing conditions—at least in our proprietary universities—it appears that the place which the president now fills, or wobbles about in, might be divided into three parts. There might be a chancellor, as in the English universities, a man of influence and of prominence, representing the corporation and the relations of

the institution to the community, concerned with increasing the endowment and prestige of the university. Then there might be a rector, as in the German universities, elected annually or for some other limited period by and from the faculties, presiding at academic functions and the like. In the third place, there would be a secretary or curator, an educational expert in charge of administrative details. In a real democracy and with a people appreciative of the needs and service of the university, the former two officials would become superfluous.

It must be admitted that the situation is difficult. The alumni are no longer predominantly scholars or even professional men. They have more concern for football than for the work of the professor; any university club could get on better without its library than without its bar. But the alumni of a university should be not less intelligent and wise than the electorate of the nation. In both cases the ultimate control must be democratic, unless perchance we are following false gods. Experts and intellectuals are not, as a rule, to be trusted to act for the common good in preference to their personal interests. The professors of an endowed university can not be given the ultimate control. A monastery or a proprietary medical school must ultimately be reformed from without. We need the referendum and the recall because we can not trust those placed in authority, and we fear these measures because we do not trust the people. An aristocracy is deaf; a democracy is blind. But it is our business to do the best we can under the existing conditions of human nature. Advancing democracy has burned its bridges behind it. No one believes that a city should be owned by a small self-perpetuating board of trustees who would appoint a dictator to run it, to decide what

people could live there, what work they must do and what incomes they should have. Why should a university be conducted in that way?

The bible is often misquoted to the effect that "money is the root of all evil." The love of money and the lack of money are indeed factors in most of the difficulties of society. Next after the getting of men, the getting of money for the university is its most troublesome problem, and next after the proper treatment of men, the use of money is the most important question. He who holds the purse strings holds the reins of power. That the president should decide which professor shall be discharged and which have his salary advanced, which department or line of work shall be favored or crippled, is the most sinister side of our present system of university administration, more pernicious in the private universities, where dismissals and salaries are kept secret, than in the state universities, where salaries are published and teachers are, or should be, dismissed, as in the better public-school systems, only after definite charges.

To transfer the control of appointments and finances from the president to the professors would strike many as passing from purgatory to a worse place. A university executive said to me the other day that if the professors were in control the first thing that they would do would be to raise their own salaries. Well, perhaps worse things have been done. It may be admitted that this is what a president usually does for himself and to an extent beyond the dreams of the most avaricious professor. But there are at least two points of difference. First, the president may increase his salary by withholding a small sum from each professor, whereas the professors could only increase their salaries by obtaining the money for the purpose. Second, it is un-

desirable for a president to receive three or four times the salary of the greatest scholar or teacher on the faculty, as is the case at California, Columbia and other institutions. It is subversive of decent social and educational ideals for the president of Harvard University to be permitted to build on the grounds of the university a house for himself costing \$100,000, and for the trustees of Columbia University to build for their president a house which with its grounds may cost twice that amount. But it would be in the interest of the university and of society if the salaries of professors were increased. Abuses are possible, but at present whatever makes the academic career more attractive to men of genius is in the interest of all the people.

The undeniable difficulties in the way of adjusting salaries and the conflicting needs of schools and departments, whether the decision rests primarily with the president, the trustees or a committee of the faculties, may be minimized by permanence of tenure and fixed salaries, and by giving the departments financial autonomy. President Van Hise, of the University of Wisconsin, and President Butler, of Columbia University, have recently pronounced in favor of the competitive system in the university. The former says: "There is no possible excuse for retaining in the staff of a university an inefficient man." The latter says: "A teacher who can not give to the institution which maintains him common loyalty and the kind of service which loyalty implies ought not to be retained through fear of clamor or criticism," and further in respect to equality of salaries: "In my judgment such a policy would fill the university with mediocrities and render it impossible to make that special provision for distinction and for genius which the trustees ought always to be able to make."

There are advantages in a system of severe competition for large prizes under honorable conditions, as well as in permanent tenure of office with small salaries and a free life; but confusion and harm result from running with the hare and hunting with the hounds. If there is to be competition in order to retain university chairs, then the university must be prepared to forego able men or to compete with other professions in the rewards it gives. It must offer prizes commensurate with those of engineering, medicine and law, namely, salaries as large as from ten to a hundred thousand dollars a year. It is further true that under these circumstances a man must be judged by his peers. A university which dismisses professors when the president thinks that they are inefficient or lacking in loyalty to him is parasitic on the great academic traditions of the past and of other nations. A single university which acts in this way will in the end obtain a faculty consisting of a few adventurers, a few sycophants and a crowd of mediocrities. If all universities adopt such a policy, while retaining their present meager salaries and systems of autocratic control, then able men will not embark on such ill-starred ships. They will carry forward scientific work in connection with industry and will attract as apprentices those competent to learn the ways of research.

Permanent tenure of office for the professor is not a unique state of privilege. A president's wife has permanent tenure of office; he can not dismiss her because he regards her as inefficient or because he prefers another woman. Analogous social conditions make it undesirable that he should have power to dismiss a professor for similar reasons. In the army and navy, in the highest courts, to a certain extent in the civil service of every country, there is

permanence of office. Indeed it is nowhere completely disregarded; service is always a valid claim for continued employment. A wife may be divorced by the courts, an army officer may be court-martialed, a judge may be impeached; but such actions are taken only after definite charges and opportunity for defence. Permanent tenure of office is intended to improve the service, not to demoralize it. It is attached to honorable offices, where public spirit and self-sacrifice are demanded, and the wages do not measure the performance. In Germany, France and Great Britain the permanence of tenure has given dignity and honor to the university chair, attracting to it the ablest men and setting them free to do their work.

Incentive to the best work of which a man is capable is not excluded from the university if the professorship itself is made a high reward, the essentials of which are permanence, freedom and honor. Men who have proved their ability for research need opportunity rather than extraneous stimulus. Still it is true that while the lack of prizes does not considerably dampen the spirit of research, it makes the academic career less attractive to those who should be drawn to it. Most of the graduate students in our universities are men of mediocre ability, drifting along with the aid of fellowships and underpaid assistantships to an inglorious Ph.D. and a profession with meager rewards. Several of my correspondents write that if large income, power and honor were not attached to the presidency, there would be no prize to attract men to university work. From my point of view it is altogether demoralizing that the reward held before the investigator and teacher should be the position of an executive, politician and promoter, which takes him away from the higher work for which he is fit. It is a curious

exposure of the situation when the president of our largest university can write:

Almost without exception the men who to-day occupy the most conspicuous positions in the United States have worked their way up, by their own ability, from very humble beginnings. The heads of the great universities were every one of them not long ago humble and poorly compensated teachers.¹⁴

It would be well if some universities would maintain professorships so highly rewarded and regarded that the possibility of a call would exercise a beneficial influence throughout the country, and if each university would establish from one to ten professorships having a salary and a prestige equal at least to that of the presidency. Vacancies in these professorships should be filled by cooptation or election by the faculties or by a faculty committee; but even under the present system of presidential nominations, it would be better to have a few important appointments made publicly than a number of small increases in salary made secretly as the result of presidential favor.

I venture to supplement my argument by quoting from an address¹⁵ made ten years ago, which seems less radical now than then, since socialism has ceased to be a nightmare for respectable citizens, since pensions have become general, since Harvard has adopted the plan of equal salaries with increments of \$500 after each five years of service, since Senator Villas has made provision at the University of Wisconsin for super-professorships, since the president of a university is no longer sacrosanct. The paragraph reads:

¹⁴ "The American as he is," by President Nicholas Murray Butler.

¹⁵ Read before the members of Phi Beta Kappa of the Johns Hopkins University, on May 2, 1902, and printed in *The Popular Science Monthly* for June, 1902.

The university is those who teach and those who learn and the work they do. The progress of the university depends on bringing to it the best men and leading them to do the best work. Our president, Mr. Remsen, in his admirable inaugural address, told us that the chief function of the university president is to find the right man, and his chief difficulty the lack of enough such men to go round. He considered the question of how far an increased salary would add to the supply of good men. I quite agree with Mr. Remsen that a professor will do about the same kind of work whether his salary is \$4,000 or \$10,000. If anywhere, in the university it should be to each according to his needs, from each according to his ability. The professor who must live in a city or who has children to educate should be given the necessary income. He should have an adequate pension in old age or in case of disablement; the university should insure his life in a sufficient sum to provide an income for his wife and minor children. The professorial chair can be made attractive by freedom, responsibility and dignity, rather than by a large salary. Still it must be remembered that we live in a commercial age, and men are esteemed in accordance with their incomes. While it may not, or at all events should not, matter greatly to the professor, it may be well for the community that those who do the most for it should be paid on the same scale as those of equal ability in other professions. It may not be necessary to double the salaries of all university men, but it would probably be desirable to have certain prizes that would represent to the crude imagination of the public the dignity of the office and would perhaps attract young men of ability. The average salaries of teachers are about the same as in the other professions, but there are no prizes corresponding to those in the other professions. A clergyman may become a bishop, a lawyer may become a judge, a physician may acquire a consulting practise; and they may earn incomes of from \$10,000 to \$100,000. A professor can only earn a large salary and an apparent promotion by becoming president of his university; and this I regard as unfortunate. As Mr. Remsen told us that the professor would be pleased, but not particularly improved, by an increase in salary, I may perhaps be permitted to suggest that a president might be pained, but would not be seriously injured, by a reduction of his salary to that of the professor. My preference in this matter would be for the professor to have a fixed salary—perhaps \$3,000 to \$6,000, according to the expense of living

in the neighborhood, with \$300 to \$600 subsidy for each of his children between the ages of 10 and 21. Advances in salary dependent on the favor of the authorities appear to be undesirable. If salaries must vary from \$3,000 to \$5,000, a man should be appointed at such salary as may be necessary, but should thereafter receive automatic increases, say of \$500 after each five years of service. Then there should be a few research chairs in each university, promotion to which would be a mark of distinction, and occupancy of which would dispense from all routine work and carry a salary equal to that of the presidency.

It is awkward to urge a reform, such as an increase in the salaries of professors or the advance of a few salaries to that of the presidency, when this would become superfluous or undesirable, if society as a whole could be reorganized on a just economic basis. Elsewhere¹⁸ I have discussed the question as follows:

The best reward for scholarly work is adequate recognition of the work as preparation for a career in life. At Columbia University a man takes his doctor's degree at the average age of 27 years. He is fortunate if he receives immediately an instructorship at \$1,000 a year; the increments of salary are \$100 a year for ten years, so that at the age of 37 he receives a salary of \$2,000. In a commercial community the imagination is not stirred by such figures. The university is a parasite on the scholarly impulse instead of a stimulus to it.

The first need of our universities and colleges is great men for teachers. In order that the best men may be drawn to the academic career, it must be attractive and honorable. The professorship was inherited by us as a high office which is now being lowered. Professors and scholars are not sufficiently free or sufficiently well paid, so there is a lack of men who deserve to be highly rewarded, and we are in danger of sliding down the lines of a vicious spiral, until we reach the stage where the professor and his scholarship are not respected because they are not respectable.

I should myself prefer to see the salaries, earnings and conveyings of others cut down rather than to have the salaries of professors greatly

increased. When a criminal lawyer—to use the more inclusive term for corporation lawyer—receives a single fee of \$800,000, our civilization is obviously complicated. Every professor who is as able as this lawyer and who does work more important for society can not be paid a million dollars a year. But neither is it necessary to pay him so little that he can not do his work or educate his children. I recently excused myself somewhat awkwardly for not greeting promptly the wife of a colleague by saying that men could not be expected to recognize women because they changed their frocks. She replied: "The wives of professors don't." It is better to have wit than frocks; but in the long run they are likely to be found together.

The first step of a really great university president would be to refuse to accept a larger salary than is paid to the professors. The second step would be to make himself responsible to the faculty instead of holding each professor responsible to him. The bureaucratic or department-store system of university control is the disease which is now serious and may become fatal. This subjection of the individual to the machinery of administration and to the rack wage is but an invasion of the university by methods in business and in politics from which the whole country suffers. We may hope that it is only a temporary incident in the growth of material complexity beyond the powers of moral and intellectual control, and that man may soon regain his seat in the saddle.

I myself accept the social ideal: From each according to his ability, to each according to his needs; and I believe that, thanks to the applications of science, the resources of society are sufficient to provide adequately for all. But the first step to take in our present competitive system is to make rewards commensurate with effective ability and a compromise between services and needs. I have pointed out that, apart from exceptional cases, the range of individual differences in many traits is about as two to one. Thus in accuracy of perception and movement, in quickness of recognition and reaction, in rate of learning and retentiveness of memory, in time and variety of the association of ideas, in validity of judgments, I have

¹⁸ "The Case of Harvard College," an address before the Harvard Teachers' Association, *The Popular Science Monthly*, June, 1910.

found in laboratory experiments a range of difference of this magnitude. The able student can prepare a lesson or earn the doctor's degree in about half the time required by the poorer student. For the same kind of work and under similar conditions the value of the services of an individual varies within somewhat the same limits. A good laboring man or a good clerk is worth as much as two who are mediocre. The value of genius to the world is of course inestimable. A great man of science may contribute more than even the most successful promoter—a Rockefeller, a Carnegie or a Morgan—gets. But such contributions are made possible by the organization of society as a whole, and should in large measure be distributed among its members, preferably in the direction of making further contributions possible. Scientific men should receive adequate rewards, and the surplus wealth which directly or indirectly they have produced—it must be counted by the hundreds of thousands of millions of dollars—should, in so far as this can be done to advantage, be spent on further scientific research.

The available wealth in the United States and Great Britain suffices to provide a home and the tools of production for each family and the productivity of labor to provide an annual income of about \$1,000 for each producer. If waste in production and expenditure were reduced, even to the extent that now obtains among teachers and scientific men as a group, there would probably be available \$1,500 for each adult, including women engaged in the care of the home, or \$3,000 for each family. If this were distributed on a range of two to one in accordance with ability, the more deserving teachers and scientific men with their wives would earn salaries of \$4,000, in addition to owning their homes. An

addition of from \$250 to \$1,000 should be allowed for each child requiring support and education, to be deducted in part from the incomes of those having no children, and allowance should be made for the varying cost of living in the city or the country and the like.

If the maximum income of a university professor or scientific man with a family should be from \$5,000 to \$10,000, no one should receive more, except to cover greater risks. There is no occupation requiring rarer ability or more prolonged preliminary training, and there is none whose services to society are greater. If there are to be money prizes—incomes of \$20,000 or \$100,000 or more—then they should be open to professors and investigators. Scientific ability is as rare as executive or legal ability, and is far more valuable to society. The lawyer who receives a fee of \$800,000 for enabling a group of promoters to get ten times as much by evading the intent of the law, does not add to the wealth of society. The scientific man who increases the yield of the cereal crop by one per cent. adds \$10,000,000 a year to the wealth of the country and five times as much to the wealth of the world. The scientific man who discovered and those who have developed the Bessemer process of making steel have, according to the estimate of Abram S. Hewitt, added \$2,000,000,000 yearly to the world's wealth. There is no reason except the imperfect adjustments of society why the lawyer should receive large rewards and the scientific man a scant salary. Those who render services to an individual or group are likely to be paid in accordance with the value of their services to the individual or group; in our competitive system those who render services to society as a whole are not paid at all, or only partially and indirectly. Of our thousand leading men of science, 738 are employed in uni-

versities and colleges, 106 in the government service, 59 in research foundations. It is the duty of these institutions to provide adequately and liberally for their support and for their work.

The rewards of the academic and scientific career deserve detailed discussion because they are of fundamental importance to the university and to society. Professors and investigators should have adequate incomes, as large as is desirable for any social class, but above all they should have opportunity to lead a life free from distracting or dishonorable compromises. It should be emphasized that nothing here written is intended to promote a privileged class of university professors. Valparaiso University and Mr. Edison's Menlo Park Laboratory are useful, as well as Harvard University and the Rockefeller Institute for Medical Research. My concern is only that the university should be of the greatest possible service to the people and to the world. It may be that the great bulk of routine teaching and routine research can be done most economically under the factory system, with a manager to employ and discharge the instructional force and bosses to keep each gang up to a square day's work. But then the highest productive scholarship and creative research must find refuge elsewhere than in such a university.

It is truly distressing that our universities should be so conventional and unimaginative, each trying to follow the lead of those bigger than itself, all lacking in fineness and distinction. The Johns Hopkins, Clark, Stanford and Chicago were founded one after the other with promise of higher things, and each has relapsed into the common mediocrity. Harvard and Yale maintain the traditions of scholarship; the Johns Hopkins and Chicago have not abandoned the ideals of research; Columbia looms up with the vastness and

crudeness of the metropolis; the state universities exhibit the promise and the immaturity of our democracy. But each and all unite the scholasticism of the twelfth century with the commercial rawness of the twentieth century. Can there not be one university where the professor will have a study instead of an office, where the ideal set before the young instructor is something else than answering letters promptly and neatly on the typewriter, where men are weighed rather than counted, where efficiency and machinery are subordinated to the personality of great men? Could there not be a university or school, dominating some field of scholarship and research with its half-dozen professors and group of instructors and students drawn together by them? Might not means be devised by which the professor would be paid for the value of his teaching, service and research, and then be set free to do his work how and when and where he can do it best? It is not inconceivable that there should be a national or state university, with some features of the royal academies, rewarding with fellowships men of unusual promise and with professorships men of unusual performance, endowing the individual instead of the institution.

If it is not possible at present to have free professors and independent schools, we can at least strive for greater freedom of the individual and larger autonomy of the department within the university. As the position and salary of the professor should not depend on the favor of a president, so the department or school should be allowed substantial autonomy. There is nothing more disheartening to the members of a department or school than to have its activities prescribed or limited, its annual appropriation apportioned, by a centralized system. A great danger confronting the modern university is its own

bulk. In the evolution of organic life a limit is placed on the size which an animal can attain. Its surface increases more slowly than its mass, and there must be differentiation and division of labor in order that the animal may grow and react properly to the environment. Even then a limit is fixed; it is doubtful whether apart from the nervous system a structure more complicated than that of the mammal will be reached, or that animals much larger than man will survive. Only a polyp or similar creature can conduct a pure democracy; the organization of higher animals must be more complicated. The growth in size of the American university has been large and rapid. Faculty or town-meeting methods have become difficult or impossible; the institution drifts into autocratic and bureaucratic control. A representative or delegated system of government is necessary for the university, as a whole, but its divisions can maintain a family and democratic system.

President Eliot says¹⁷ that a long tenure of office will be an advantage to the president and to the university he serves, but that the chairman of departments should be chosen for short periods and should generally be junior or assistant professors to give them opportunity and because "dangers from the domination of masterful personages will be reduced to a minimum under this system." It is not evident why it is less desirable to limit "the domination of masterful personages" in the office of the president or of the dean than in the department. But it is true that a departmental autocracy may be even worse than one on a larger scale, and for the reason that it is conducted in the dark. A president may say that a teacher "ought not to be retained through fear of

clamor or criticism," but fortunately public opinion does prevent the more serious abuses to which the system is liable. In certain departments of certain universities instructors and junior professors are placed in a situation to which no decent domestic servant would submit. Clearly that is no breeding ground for genius and great personalities.

It can not be denied that the organization of the departments of a university is one of the difficult problems that confront us. The German plan, according to which the individual rather than the department is the unit, is in many ways preferable. But the American university conducts what is practically a secondary school in the first two years of the college, and it conducts professional schools which are not of university grade. The high schools and small colleges should take over the first two years of the college, establish schools of agriculture and of the mechanic arts, and conduct courses preparatory to medicine, law, engineering and teaching. In a large state, the state university would have one hundred thousand students, if it received all the young men and women between the ages of sixteen and twenty who should continue educational work. Such education should be provided locally and in connection with productive industry, as in the admirable plan adopted by the school of engineering of the University of Cincinnati, by which students work alternate weeks in the university and in the shop. Under President Eliot, Harvard placed both its college and its professional schools on a university basis; under President Lowell, it has moved backward in the direction of making the college a school of information and culture and of requiring the professional school to begin with the elements. To such an extent is the university the plaything of its president!

¹⁷ "University Administration."

For administrative and financial purposes it seems necessary to organize the university into schools, divisions or departments, although for educational purposes as much flexibility as possible should be maintained. The scope and size of such a division should depend on convenience and local conditions, rather than on logical distinctions among the subjects taught. A small college or a small medical school can be conducted to advantage under one faculty. In a large university there is no need to have a separate department for each of the oriental languages because they differ from one another more than do the European languages, though it may be desirable to have separate departments for German and French. When a medical school, or even the work in a special science, such as chemistry, becomes large, it may be advisable to organize it into partly autonomous divisions. There is no gain in economy and usually a loss in cooperation and effectiveness when the entering class of a college or professional school exceeds fifty or a hundred, and when its faculty exceeds twenty or thereabouts. Colleges should remain small; if a university must have a great crowd of college students, they should be divided among separate colleges, as in the English universities. These colleges should not, however, consist of freshmen, as President Lowell plans, or of students belonging to a certain social class, as is likely to happen under the fraternity and club system, but of men having common intellectual interests. Even small colleges for general education should aim to excel and to do research work in some special direction. In the large university the residential colleges and departments should coincide, so that younger men will join a group of older students and instructors having similar interests and ends in life. As I have elsewhere remarked:

The ideal is the zoological hall of the old Harvard, where apprentices of a great man and a great teacher lived together. This is told of again in the charming autobiography of Shaler. A boy from the aristocratic southern classes, with ample means and good abilities but no fixed interests, fell into this group. There he discovered his life work and pursued it with boundless enthusiasm. Nor did the fact that he devoted himself exclusively to professional work in natural history in college prevent him from writing Elizabethan plays in his old age. The number of men of distinction given to the world from this small Agassiz group is truly remarkable.

A group of some 10 to 20 instructors, having registered primarily under them from 50 to 200 students, is a good size for a school, division or department. Each can be well acquainted with the others and take a personal and intelligent interest in all the work of the department. At the same time the number is sufficient to permit the representation of diverse kinds of work and points of view, and to make possible the election of officers and a democratic control. The chairman or head and an executive committee should of course be elected, not named by a semi-absentee president. In a group of this character questions are not usually brought to a vote. In reaching decisions each member is likely to be weighed as well as counted. In my experience the junior members of a faculty or department take too little rather than too much share in its discussions and its control. If they obtained constitutional rights they might become more aggressive; if they should, so much the better. One of the serious difficulties of the present system is that the younger men do not share in the conduct of the university and do not feel themselves to be part of its life. Those who do not have their ideas before they are thirty are not likely to have them. The paraphernalia and camp baggage of modern civilization have become so heavy that they threaten to block its further advance. If men must devote thirty years to mere

acquisition, and be kept even longer in official subjection, there is not much chance that they will do anything else thereafter. What youth can do should be joined with what age can know.

Voting rights in a department might be in proportion to the salary the officers receive; but such statutory regulations are scarcely needed. The real control is vested in the aggregate common sense of those concerned. The group may well be flexible in character. When courses of instruction and educational problems are under discussion assistants and even graduate students may be admitted to advantage. When the question is the promotion of an instructor, the group would naturally be limited to those of higher office. The chairmanship of the department might rotate among its members or the same head might be reelected continuously according to convenience. It by no means follows that the professor most eminent in research should be the executive head; on the contrary, it should usually be a man of competent administrative ability whose time is of less value. Every reasonable man believes in economy in administration and letting the men do things who can do them. Even the most important decisions can be left to the head of the department or its executive committee, so long as they represent and are responsible to the whole department.

The school or department should have complete control of its own educational work. So long as there is ample room for differences of opinion as to the value of different subjects and methods, it is well that there be variation and survival of the fit. Entrance requirements and degrees are among the chief obstacles to education. An instructor in Columbia University said recently to a student who had just received the highest grade assigned in the course:

"Why did you take the course, if you don't want a degree?" If there must be degrees, it may be necessary to standardize them; but this should be done only to the extent of prescribing the amount of work to be done in the direction called for by the degree, this being determined by the time spent, weighted in accordance with the ability of the student. I shall print shortly statistics in regard to all doctorates of philosophy granted in the sciences by American universities. For each department of each university will be given the percentage of doctors who continued to pursue scientific work and the percentage who attained a given degree of distinction. If any police regulation is needed, such publicity is far better than the examination of a candidate before the faculty, or the requirement of all sorts of qualifications.¹⁸

Financial as well as educational autonomy should be given to the school or de-

¹⁸ This paper is concerned with problems of administration, not with questions of teaching and research. The latter are by far the more important; indeed administrative methods are only of consequence in so far as they affect education within and without the university, research and the applications of knowledge. Incidentally I may remark that I should give the student the same freedom and the same democratic system that I should like to see the teacher enjoy. I should admit to the university any student and let him stay there so long as his presence did not do injury to others. I should let him choose his own work and his own methods of work, not because all kinds and methods of work are equally good, but because I regard myself as incompetent and most of my colleagues as even more incompetent to impose any system on the student. I should in large measure do away with grades, required attendance, required courses, required examinations and degrees, not because these things are not in some ways and in some cases useful, but because on the whole they do more damage than good. So far as possible, I should let students manage their own affairs, their dormitories, fraternities and athletics, their codes of manners and of morals.

partment. Its total income should be held as a trust fund, to be decreased only after full and public investigation. The laboratories, rooms, apparatus, equipment, library, etc., should be held in trust for the department, to be taken away against its will only for clear reasons and on the recommendation of a competent faculty committee. Under these conditions the members of a department will plan on a safe basis for the future, and will seek to increase its funds and facilities. I know of a case in which a professor obtained a gift of \$100,000, made expressly "to increase the facilities of the department," and the income was assigned by the president and trustees to pay the salary of that professor against his earnest protest. I also know of a case in which a department which had built up one of the strongest laboratories in the country had those of its rooms especially devoted to research taken away and given to a weak department, to induce a certain professor to accept a call from elsewhere to the headship of the weak department. These are of course extreme cases and might seem incredible, if it were not that interference with the vested rights of departments is of frequent occurrence.

The Harvard plan of visiting committees which may take an active interest in the educational work and financial support of departments is commendable. Under the existing trustee system it might be well if one trustee would concern himself especially with one or two departments, attending their meetings and doing what he could to advance their interests. There can to advantage be within the university departments related to its educational work, but under independent control. Thus the most useful and vigorous division of Columbia University, with the possible exception of the faculty of political science, is

the Teachers College, which is under its own trustees with a dean and faculty responsible to them. As a department of education under the trustees of Columbia College, it would probably have had no more leadership than the departments at Harvard or Yale. The educational alliance between Columbia University and the Union Theological Seminary is far better than a school of theology under the trustees of the university. There is no valid objection to two schools of law or two schools of chemistry, independently controlled, but enjoying the advantages of educational affiliation with a university. Endowed research institutions and municipal, state or governmental bureaus, can to advantage be placed near a university, contributing to and gaining from its educational work.

Appointments and the apportionment of funds are said to be questions insoluble under democratic control. But in spite of the difficulties the case is not so bad as autocratic one-man power. If there are fixed salaries with automatic increases, only three or four decisions must be made. Shall this man be appointed instructor? Shall he be appointed junior professor after five or ten years of service as instructor? Shall he be appointed full professor after five or ten years of service as junior professor? Who shall be appointed to super-professorships, if such exist? As a matter of fact under the existing system instructors and junior professors are nearly always nominated by the department or its head. They alone have the necessary information in regard to the men and the situation. The nomination of a full professor can be entrusted better to the department concerned than to a president. But such an appointment being for life and of immense consequence can not be too carefully guarded. It should be passed on by

a board or committee composed, say, of two members of the department, two members of allied departments and two distinguished representatives of the subject outside the university concerned. Such control would prevent undesirable inbreeding or the further deterioration of a weak department. Nominations should be made publicly—the English plan of definite candidates with printed records has much to commend it—and the power of veto should perhaps be given to the faculties as well as to the trustees.

The apportionment of the existing income of a department varies but little from year to year, and can safely be left to the department. Questions arise only when an increase which the department can not itself obtain is wanted, and there are general funds available, but not sufficient to supply all the needs of the university. Under the existing system each head of department grabs for everything in sight, and the president plays the part of an inscrutable and sometimes unscrupulous providence in the semi-secret distribution of his favors. No scheme could be more demoralizing. The correct plan is for each department to draw up its budget, with requests for increases and the reasons clearly indicated, the proposed budgets being printed and open to all concerned. Under these conditions unreasonable claims would not often be made by the departments. Plans for new departments and new lines of work could also be submitted by any responsible group. An elected committee of professors, with the assistance of an expert curator or controller, would then pass on the various budgets and proposals and adjust them to the available income, the reductions made by the committee being of course published. The budget for the university would then go to the trustees. It may be objected that under this

plan existing work would be strengthened rather than new ground broken. But might not this be better than the existing presidential mania for expansion? It seems in fact probable that if many professors and junior instructors were concerned, there would be more new ideas than when the initiative is left to a single man, and further that wise plans would be more likely to be adopted and inexpedient schemes to be rejected.

When schools and departments have autonomy, there is no need for much super-legislation and super-administration in the university. The machinery should be as simple as may be. Departments may be united into a school or college and elect a dean and a faculty or an executive committee to coordinate the work. A department can elect members to represent it in allied departments and on the faculties of the schools and colleges with whose work it is concerned. There should be an elected council or senate to represent the entire university and an executive committee which can confer with the executive committee of the trustees. There may at times to advantage be faculty meetings or plebiscites of large groups or of all the officers of the university. Questions concerning the entire university can be discussed to advantage by the fly-leaf method of the English universities, and a vote can be taken without a general assembly at a polling booth or by mail.

There are advantages and disadvantages in large faculty meetings. When all important matters are decided by administrative officers or executive committees and only trivial questions are discussed before the faculty, usually by certain polyphasic members, its meetings are likely to fall into disrepute. Men are efficient in direct proportion to their responsibility. Further, a body of men is effective inversely as its

size and directly as the time it works together. A body of fifty men such as the faculty to which I primarily belong, meeting for an hour three times a year, without power or responsibility, is clearly dedicated to futility. But if any one supposes that university presidents would do better under these conditions, he should call to mind the conduct of the trustees of the Carnegie Foundation. It seems to be the case that in order to make large faculties real legislative bodies, it would be necessary to devote more time to their meetings than is expedient, and perhaps more common sense than is available. All parliaments, congresses and legislatures do their work through cabinets and committees; but these are responsible to the whole body. Some such plan is necessary in the university. Still the cynical attitude toward faculty meetings common in academic circles appears to be one of the sinister symptoms resulting from the existing methods of autocratic control. It is typical of existing conditions that the most recent university school to be established—the School of Journalism of Columbia University—does not have a faculty but an “administrative board.” I belong to a club at the meetings of which each member must speak once and only once, not exceeding his share of the time, and the discussion is followed by a dinner. If faculty meetings could be made into educational and social clubs they would perform a useful function. The meetings of the faculty of arts and sciences at Harvard may give rise to complaints, but they have been of real service to the university.

Truth, openness, publicity, are the safeguards of free institutions. It is better to wash your dirty linen in public than to continue to wear it. The affairs of a university should be conducted in the full light of day. The proceedings of the trus-

tees, the discussions and conclusions of faculties and of committees, the activities of the president, the work of professors, salaries and the provisions of the budget, the appointment of officers and the rare cases in which it is necessary to dismiss a professor, should be open to all. Light is an excellent disinfectant; what is of more consequence, it is essential to healthy life and growth. “And God said, let there be light: and there was light. And God saw the light, that it was good.”

Several of my correspondents argue that if the control of a university were vested in its teachers, they would be distracted from their proper work of teaching and research. In a recent article¹⁹ on “The University President in the American Commonwealth,” President Eliot writes:

Most American professors of good quality would regard the imposition of duties concerning the selection of professors and other teachers, the election of the president, and the annual arrangement of the budget of the institution as a serious reduction in the attractiveness of the scholar's life and the professorial career.

Do President Eliot and the lesser presidents and the few professors who share their views believe that university professors and other citizens of a city should not concern themselves with municipal government or vote for a president of the nation? Are we of the world's greatest democracy and in the twentieth century to revert to the theory that the common people should do the daily work imposed on them, and trust to the king and his lords to care for them?

In the preface to the first edition (1906) of the “Biographical Directory of American Men of Science,” I wrote:

There scarcely exists among scientific men the recognition of common interest and the spirit of cooperation which would help to give science the place it should have in the community. It is fully

¹⁹ *The Educational Review*, November, 1911.

as important for the nation as for men of science that scientific work should be adequately recognized and supported. We are consequently in the fortunate position of knowing that whatever we do to promote our own interests is at the same time a service to the community and to the world.

Trade unions and organizations of professional men, in spite of occasional abuses, have been of benefit not only to those immediately concerned, but to society as a whole. President Eliot did not obtain commendation for calling the "scab" a hero. But if it is expedient to better the conditions under which work of any kind is done, this is of the utmost importance for education and research. If we can unite to improve the conditions of the academic career, so that it will attract the best men and permit them to do their best work, we make a contribution to the welfare of society which is permanent and universal. It may be that the time has now come when it is desirable and possible to form an association of professors of American universities, based on associations in the different universities, the objects of which would be to promote the interests of the universities and to advance higher education and research, with special reference to problems of administration and to the status of the professors and other officers of the university.

The space at my disposal is exhausted and many problems directly and indirectly concerned with the control of a university remain untouched. I am well aware that this paper is written in the spirit of the advocate and the reformer, rather than from the point of view of the judge and the responsible administrator. Against most of the suggestions which have been made valid objections may be urged. The only principle that I am prepared to defend whole-heartedly is that the university should be a democracy of scholars serving the larger democracy of which it is a part.

A government of laws is better than a government by men; but better than either is freedom controlled by public opinion and common sense, by precedent and good will. As that nation is happy which has no history, so that university is fortunate which has the least administration, and my most inclusive answer to the question how to administer a university is—don't.

J. McKEEN CATTELL

SCIENTIFIC NOTES AND NEWS

THE cost of preparing for publication the unfinished manuscripts left by the late Professor C. O. Whitman, together with that of the publication of the same in the best possible manner when ready, has been undertaken by the Carnegie Institution of Washington. Provision is also made for the maintenance of the large collection of pigeons, and for the current researches with them. Dr. Oscar Riddle, in charge of the work, has been appointed a research associate in the Carnegie Institution.

THE University of California has conferred the doctorate of laws on Dr. George E. Hale, director of the Solar Observatory of the Carnegie Institution, and on two of its graduates, Dr. Sidney E. Mezes, professor of philosophy and president of the University of Texas, and Dr. E. C. Sanford, professor of psychology and president of Clark College.

CAMBRIDGE UNIVERSITY will give the honorary doctorate of science to Major Leonard Darwin, lately president of the Royal Geographical Society.

THE University of Manchester will confer the degree of doctor of science on Dr. B. H. Scott, F.R.S., the distinguished botanist.

PROFESSOR NOCHT, director of the Tropical Institute at Hamburg, succeeds Professor Baelz as president of the German Tropical Society.

KING ALFONSO has given an audience at Madrid to Mr. Marconi, and has conferred on him the Grand Cross of the Order of Alfonso XII.

THE members of the Bureau of Chemistry have presented to Dr. H. W. Wiley, as a farewell gift, a chest containing 144 pieces of flat silver, a massive meat platter with side dishes, and a porringer, pap spoon and cup for Harvey W. Wiley, Jr., born on May 16. The plate on the mahogany chest is inscribed as follows: "To Harvey W. Wiley, whose leadership has been an inspiration to all who have had the privilege of knowing personally, day by day, the breadth and depth of his well-stored mind, his unshakable integrity and his splendid poise and never-failing geniality under any and all conditions. From the Bureau of Chemistry, U. S. Department of Agriculture, 1883-1912."

AN expedition for the further collections of fossil American horses for the Peabody Museum, Yale University, will be conducted this summer under the direction of Professor Richard S. Lull, associate curator in vertebrate paleontology. The party will explore in the Panhandle region of Texas and the banks of the Niobrara River in central Nebraska. Mr. Frederick Darby, one of the preparators in the Peabody Museum, and possibly one or two volunteers will accompany the expedition.

MR. A. E. PRATT, accompanied by his son, Mr. Felix B. Pratt, arrived in Piura, Peru, on May 3, direct from London *via* Barbados and Panama. They outfitted in Piura for the trip overland to Iquitos on the Upper Amazon. The object of the expedition is the collection of natural history specimens, chiefly butterflies, beetles and birds. The first sets go to a private collection and the rest to the British Museum of Natural History. Mr. Pratt and his son have spent three years in similar work in the interior of New Guinea, and have also worked in Australia, Madagascar and South America. They carry a full outfit and will proceed by way of Huancabamba, Jaen and the Marañon. From Iquitos they will follow the Amazons down to Pará, and thence back to England.

THE *Journal* of the American Medical Association states that the scientific investigations at Teneriffe have received a new exten-

sion by the erection of a station for observing anthropoid apes. Professor Rothmann, of Berlin, and Frau Professor Selenka, of Munich, have been sent to Teneriffe by the department of education to make preparations to this end, since it may be expected that in the uniformly warm climate there the animals may be kept in the open air through the entire year under the conditions of life that are natural to them.

MR. ARTHUR MAURICE HOCART has been elected to a senior scholarship at Exeter College, Oxford, for two years for the purpose of carrying out anthropological research in Fiji.

PROFESSOR JOSEPHINE E. TILDEN, of the University of Minnesota, has been given leave of absence on half salary, for the coming year, to carry on botanical research in the Islands of Tahiti and New Zealand.

PROFESSOR ARTHUR GORDON WEBSTER, of Clark University, sailed on the *Mauretania* on May 22 to take part as a delegate of the United States government in the Radio-Telegraphic Conference held in London in June, to represent Clark University at the quarter-millennial celebration of the Royal Society in July and to attend the International Congress of Mathematics at Cambridge in August. Professor Webster is one of the six Americans whose names appear on the international committee of the congress.

DR. WILLIAM H. F. ADDISON, of the medical department of the University of Pennsylvania, has sailed for Germany, to study with Professor Edinger at Frankfurt-am-Main.

T. POOLE MAYNARD, Ph.D. (Hopkins), has resigned as assistant state geologist, Geological Survey of Georgia, and will open an office as a consulting and mining geologist.

H. R. FULTON, associate professor of botany in the Pennsylvania State College and botanist in the station, has been appointed botanist and vegetable pathologist in the North Carolina College and Station.

DR. BERNHARD FITTIGE, associate professor of chemistry at Marburg, died on April 27, aged sixty-two years.

PROFESSOR F. O. GROVER, head of the department of botany in Oberlin College, has been appointed by the faculty to represent the college in the Ohio Biological Survey.

PROFESSOR G. C. COMSTOCK delivered the annual Sigma Xi address at the University of Michigan on May 24, speaking on "The Visible Universe as a Subject of Current Speculation."

PROFESSOR ELIOT BLACKWELDER, of the University of Wisconsin, delivered an illustrated lecture on "The Physical Geography of China and its Influence upon the People," on May 3 under the auspices of the College of Science Student's Union of the University of Illinois. The union was organized this year with representatives from the various scientific societies, and it has been so successful that the engineering societies are planning a similar union. Professor H. C. Taylor, head of the department of agricultural economics at the University of Wisconsin, gave three lectures at the University of Illinois on May 16 and 17 on the following topics: "The Economic Conditions which Determine Types of Dairy Farming," "The Economic Aspects of the Farm Problem," and "The Value of Cost Accounting on the Farm." Dr. A. L. Winton, of the Chicago Laboratory of the U. S. Bureau of Chemistry, lectured last week at the university on "Microscopic Food and Agricultural Analysis," under the auspices of Phi Lambda Upsilon, the honorary chemical fraternity.

THE one hundred and thirtieth Harveian festival will be held in the hall of the Royal College of Physicians, London, on May 31, when the president, Dr. Charles Watson MacGillivray, will give the Harveian Oration on "Some Memories of Old Harveians, with Notes on their Orations."

UNDER the auspices of the Geographical Society of Philadelphia, a botanic and geographic expedition is to be made this summer to southern Florida by Professor John W. Harshberger, of the University of Pennsylvania. Professor Harshberger has made two previous trips to Florida and this expedition is to complete his studies in the Everglades region of the extreme southern part of the

peninsula. The itinerary will be approximately as follows: Making Fort Meyers on the west coast headquarters, Professor Harshberger will first investigate the region in that vicinity; visits will be made to several of the islands along the gulf coast; the Caloosahatche will be ascended by power boat to Lake Okeechobee and the flora of that inland lake will be studied. Then the attempt will be made (if the drainage canal has been sufficiently constructed) to cross the Everglades to Fort Lauderdale on the east coast. As no botanical geographer has ever crossed the Everglades, unusual opportunities will be presented to study a region of great scientific interest. Photographs will be taken of the vegetation, the region will be mapped botanically, and a collection of the more interesting plants will be made. An abstract of the results of this expedition will be published in the October number of the *Bulletin* of the Geographical Society of Philadelphia.

THROUGH the liberality of a friend, the Smithsonian Institution will be enabled to participate in a zoological expedition to the Altai Mountain region of the Siberian-Mongolian border, central Asia, an exceedingly interesting territory, from which the National Museum at present has no collections. Mr. Ned Hollister, assistant curator, division of mammals, U. S. National Museum, will represent the institution and make a general collection of the birds and mammals. He will have as a field assistant Mr. Conrad Kain, of Vienna, Austria, an Alpine guide. The party leaves New York on May 22 for London, whence the field will be reached by way of St. Petersburg and the Siberian Railway. The scene of the survey and exploration, the Altai Mountain region, is a particularly wild country. These mountains are inhabited by the largest of the wild sheep, which, with the ibex, will form the principal big game animals sought by the party, but a complete and general collection of smaller mammals and birds will also be made. At present it is the expectation of the party to remain in the field for four months, returning to the United States about the first of October.

UNIVERSITY AND EDUCATIONAL NEWS

MR. CLARENCE H. MACKAY and his mother, Mrs. John W. Mackay, have given \$150,000 to the University of Nevada, making their total gifts \$400,000.

ALLEGHENY COLLEGE has completed the raising of \$400,000 thereby securing the \$100,000 conditional gift of the General Education Board. This makes the total productive endowment of the college \$1,025,000. At the same time \$20,000 has been given for a new athletic field, \$20,000 to pay a deficit in running expenses and \$60,000 as an endowment fund which is not immediately productive. President Crawford stated in his announcement on the completion of the fund, that the immediate results would be the addition of two new assistant professors and several new instructors to the faculty and the giving of an additional income to the library.

THE corner-stone of the new \$125,000 School of Commerce building of the University of Illinois, was laid on Tuesday, May 21. A special university convocation was held in the auditorium at 4 P.M. Addresses were given by Governor Charles S. Deneen, of Illinois; President E. J. James, of the University; Dean David Kinley, director of the Course of Commerce; President W. L. Abbott, of the board of trustees, and others. In addition to the usual subjects taught, such as insurance, public finance, business organization and economics, etc., the school will give courses in shop and factory organization and management.

DR. C. A. DUNIWAY, whose term of office as president in the University of Montana, was, as readers of SCIENCE will remember, terminated by the regents, has been elected president of the University of Wyoming. The University of Wyoming has about twice the income of the University of Montana.

DR. ALEXANDER MEIKLEJOHN, professor of philosophy and dean of the faculty of Brown University, has been elected president of Amherst College.

PROFESSOR B. M. DUGGAR, of Cornell University, has been elected to fill the professor-

ship of plant physiology and applied botany in Washington University, vacated by Dr. George T. Moore in accepting the directorship of the Missouri Botanical Garden.

MR. REYNOLD K. YOUNG (A.B., Toronto, '09), for the past three years fellow in Lick Observatory, has been appointed instructor in astronomy and physics in the University of Kansas. Mr. Young takes his doctor's degree from the University of California in June.

MR. ANSEL F. HEMENWAY, of the University of Chicago, has been appointed professor of biology and geology in Transylvania University, Lexington, Ky., to succeed Professor Charles A. Shull who has recently resigned.

PROFESSOR J. K. H. INGLIS, of University College, Reading, has been elected professor of chemistry at Dunedin University College, New Zealand.

DR. RICHARD GANS, docent for physics at Strasburg, has been elected professor of experimental physics at the University of La Plata.

MR. JAMES HENDRICK, lecturer in chemistry at Aberdeen Agricultural College, has been appointed professor of agriculture in the university.

DR. HERMANN BRAUS has been promoted to be full professor and director of the anatomical laboratory at Heidelberg.

DISCUSSION AND CORRESPONDENCE

THE WHITE-TAILED DEER OF MICHIGAN

Two white-tailed deer, *Odocoileus virginianus* Bodd. and *O. v. borealis* Miller, are said to occur in Michigan. The northern form (variety *borealis*) is still abundant in the northern peninsula, and numerous specimens from that region are in the University of Michigan Museum of Natural History. But unfortunately in the southern peninsula the deer have become nearly exterminated, and as apparently but very few specimens or sufficiently careful descriptions of specimens

have been preserved, and this is the part of the state in which one would look for the typical form, the problem of determining the species that formerly inhabited this region is not an easy one to solve.

The northern limit of the range of the typical form has only been vaguely given by the different authorities. Thus Hahn¹ says "from the region of the Great Lakes," Rhoads² states that it occurs "from southern New York and Michigan," and Seton³ gives it approximately the two southern tiers of Michigan counties in his map of the range of the species. Apparently none of these statements are based upon definite information, as we have been unable to find any specimens or information that would lead us to believe that the typical form ever occurred in Michigan even in the southernmost counties.

There are two skulls from Wexford county in the museum that are evidently to be referred to variety *borealis*, the lower row of cheek teeth measuring 83 mm.⁴ in one and 79 mm. in the other, which has not yet acquired the rear lobe of the third molar. This confirms the opinion held by most writers that the northern form is found in the northern part of the lower peninsula. There are also in the collection, however, a skull from Livingston County (No. 5240) and sub-fossil jaws from Washtenaw County (No. 42,532) and Branch County (No. 42,531) in which the lower row of cheek teeth measures 83 mm., 82 mm. and 90 mm., respectively. These specimens with the statements of former residents⁵ of Washtenaw and Wayne counties that the deer of these counties had a gray coat in winter seems to constitute pretty clear evidence that the variety *borealis* formerly ranged

clear to the southern boundary of the state to the exclusion of the typical form.

ALEXANDER G. RUTHVEN,
NORMAN A. WOOD

UNIVERSITY OF MICHIGAN
MUSEUM OF NATURAL HISTORY

THE FLORA BRASILIENSIS

TO THE EDITOR OF SCIENCE: Referring to the note regarding the set of the "Flora Brasiliensis" recently acquired by the University of Illinois and the statement that it is the fourth obtained by American libraries, the others being at Harvard, Columbia and the Shaw Botanical Gardens,¹ it may be worth while to state that there is a complete set in the library of the Academy of Natural Sciences of Philadelphia, the volumes issued prior to the abdication of Dom Pedro II. having been received as a gift from him in evidence of his appreciation of the attentions shown him by the academy in 1876, during his attendance on the Centennial Exposition.

A detailed account of the emperor's visit will be found in my "History of the Academy."

EDW. J. NOLAN,
Secretary and Librarian

TO THE EDITOR OF SCIENCE: In your department of "Scientific Notes and News" of April 26, 1912, there is a statement that the set of "Flora Brasiliensis," which has just been added to the natural history library of the University of Illinois makes the fourth set obtained by American libraries, "others being at Harvard, Columbia and the Shaw Botanical Gardens." Will you kindly mention the fact in SCIENCE that the library of the Ohio State University has a complete set of "Flora Brasiliensis"? In the very early days of the university the first parts of the "Flora" were presented to the university by Mr. William S. Sullivan, of Columbus, with the understanding that the university would keep up the subscriptions. This was done and the parts as issued were received regularly by the university library. On the completion of the

¹ SCIENCE, XXXV., No. 904.

¹ Hahn, W. L., "The Mammals of Indiana," 33d Ann. Rept. Indiana Dept. of Geology and Natural Resources, 1908, p. 458.

² Rhoads, S. N., "The Mammals of Pennsylvania and New Jersey," 1903, p. 24.

³ Seton, Ernest Thompson, "Life-Histories of Northern Animals," 1909, p. 75.

⁴ The length measured along the grinding surface of the teeth.

⁵ See "Michigan Pioneer and Historical Collections," Vol. IV, p. 486 *et seq.*, and p. 542.

work it was bound in volumes, making a very handsome as well as valuable set.

OLIVE JONES,
Librarian

AN EXPERIMENT ON A FASTING MAN

THERE was completed at this laboratory on May 15 a successful 31-day experiment during complete inanition, the subject drinking 900 c.c. of distilled water per day. Elaborate measurements of the gross metabolism as indicated by the carbon dioxide production, oxygen consumption, water vaporized and heat elimination were made on each day. Continuous records of rectal temperature, pulse rate, respiration rate, ventilation of the lungs, blood pressure, microscopic blood examination, careful clinical examinations, anthropometric measurements and psychological tests were a part of each day's routine. Photographs of the subject at stated times and X-ray plates at the conclusion of the fast were secured. Complete urine analyses were also made throughout the 31 days. The mass of data will require several months for complete and verified computation.

Newspapers and magazines, actuated only by the sensational element, have used every means to secure advance statements, and in some instances have issued "faked" statements, regarding this experiment. The results will be presented only in the publications of the Carnegie Institution of Washington or in the regularly accredited scientific journals, and any prior statements purporting to be made by me or signed by the subject, A. Levanzin, are to be disregarded.

FRANCIS G. BENEDICT

NUTRITION LABORATORY OF THE
CARNEGIE INSTITUTION OF WASHINGTON,
BOSTON, MASS.,
May 15, 1912

SCIENTIFIC BOOKS

The Pines of Australia. By RICHARD BAKER and HENRY G. SMITH. Technical Education Series, No. 16. Sydney, 1910.

The present publication of the department of public instruction of the state of New South Wales is a memoir of over four hun-

dred and fifty pages, copiously illustrated by means of photographs and photomicrographs and accompanied by two maps showing the distribution of the "Pines." Many of the illustrations represent more or less accurately the appearance of stained microscopic sections reproduced by the three-color process. It seems questionable even in a semi-popular work like the present to use the term "Pines" to represent the Conifers as a whole. Such an appellation is almost sure to lead to misconceptions on the part of the reader, particularly in the southern hemisphere, where true pines are conspicuous by their absence. The authors are at some disadvantage on account of the multifariousness of the task they have set themselves, for they aim to include in their account of these trees, their systematic relations, the history of the names given them, their morphology and anatomy, their useful products, including the chemistry of some of these and finally their geographical distribution. This appears to be too large a field to be covered successfully or fully, even by the collaboration of a chemist and a botanist.

Under the head of morphology and anatomy are recorded observations as to the significance of the "spur" of the cone scale of the genus *Callitris* and the probable function of the central columella in the cone of the same genus. It is noted that the chemical products, particularly the resinous ones of species which resemble one another morphologically are very strikingly similar. Attention is called to the presence of manganese compounds in the parenchymatous cells of the wood of *Callitris* and other genera. The manganese content in some cases is very considerable. The value and nature of the tannins and sandarac resins of *Callitris* are discussed and similar accounts are given of the gums, resins and oils of the other coniferous genera of the Australian flora.

The volume concludes with appendices on the systematic value of the chemical products of plants, on the distribution of Australian conifers, and on the collaborators, who have assisted in various ways in the preparation of the work. There are likewise several good

maps which further illustrate the subject of distribution. The present work will be of considerable value to those interested in the economic products of Australia and to botanical travelers in that region.

The Eusporangiatae, the Comparative Morphology of the Ophioglossaceae and Marattiaceae. By DOUGLAS HOUGHTON CAMPBELL, Carnegie Institution of Washington, August, 1911.

This superb memoir deals with the representatives of two important orders of ferns, the Ophioglossales and the Marattiales, which on account of their remote and often tropical distribution are imperfectly known. The illustrations are admirable scientifically and are often extremely artistic. Thirteen full quarto page heliotypes representing the habit of the rarer species are of great beauty. While the author deals adequately with those features of the morphology of the Eusporangiatae, which have been accessible to other writers, he naturally devotes special attention to the question of the structure and development of the gametophytes and the young sporophyte, since it is precisely in regard to these matters that our present knowledge is least perfect. With entirely admirable zeal, Professor Campbell has made it his business to visit those remote parts of our earth which are at the same time most interesting botanically and least salubrious and accessible.

An account as complete as is permitted by the abundant material rendered available by the author's extensive travels is given of the gametophytes of the three Ophioglossaceous genera, *Ophioglossum*, *Botrychium* and *Helminthostachys*. This is supplemented by descriptions of the development of the embryo and the later stages of the young sporophyte. It is clear that Professor Campbell inclines to the opinion that the leaf is the primitive fern organ and for him the genus *Ophioglossum* is likewise the primitive genus of the Ophioglossaceous family. There appears to be here much room for difference of opinion, since the whole tendency of investigation in recent years, covering both the living and fossil rep-

resentatives of the lower vascular plants, whether cryptogamic or seed-bearing, has been to show that the course of evolution has been from the more complex to the simple and not as has been generally assumed in the past *vice versa*. Unfortunately in the case of the Ophioglossaceae no fossil evidence is available to check up the results obtained from the study of the morphology of the living forms. In accordance with his point of view, the author apparently regards the stem of the Ophioglossaceae as a complex of fused leaf bases, a conception supported in his opinion by the method of development of the vascular strands. He apparently regards the fertile segment of the leaf too, the so-called sporangiophore, as an organ *sui generis*, although Professor Bower, the most vigorous defender of this point of view, has recently practically abandoned it. The possibility of the sporangiophore representing specialized pinnae of the leaf, which has recently been convincingly urged by Professor Chrysler, is not entertained.

The account of the Marattiales given by the author is particularly full and original and does full justice to the admirable opportunities of travel and collection which he has enjoyed. Of particular interest is the account of the gametophyte, sexual organs and embryonic development of the monotypic genus *Kaulfussia*, by reason of its marked resemblance to the fossil forms referred to the Marattiales. A feature of this second division of the memoir is the attention given to the development of the fibrovascular system. The author takes the position that the origin of the first tracheids as separate groups, which only later become merged in the general fibrovascular system of the stem, indicates the origin of the axis from originally separate parts. This doctrine carried to its logical conclusion would apparently lead to somewhat striking absurdities.

The third division of the memoir is devoted to the discussion of the origin and relationship of the two fern families described in the earlier pages. The author assumes the correctness of the antithetic hypothesis of the origin of the alternation of generations, char-

acteristic of all vascular plants. In this connection he definitely homologizes the moss sporogonium with the sporophyte of ferns. Obviously he entertains the view that *Ophioglossum* among the Ophioglossaceæ is probably the most primitive representative of the fern stock. There appears to be little support for the correctness of this view and it entirely lacks the confirmation of fossil evidence, which in this case is unfortunately lacking. Logically in accordance with the general attitude just indicated, the author derives the Marattiaceæ from ancestors allied to the Ophioglossaceæ. He acknowledges in this connection the serious difficulty of bridging over the morphological gap, between the dorsisporangiate foliar organs of the Marattiales and the so-called sporangiophore of the Ophioglossales. This difficulty appears to the reviewer to be very great indeed, especially in view of the known antiquity of the Marattiales and the apparently recent origin of the Ophioglossales. It further appears from a consideration of the reproductive parts and anatomy of the sporophytes as well as of the gametophytes, that it is much easier to derive the Ophioglossaceæ from typical ferns such as the Marattiaceæ, than it is to entertain the possibility of a reverse course of evolution.

The Morphology of Gymnosperms. By COULTER and CHAMBERLAIN. University of Chicago Press. 1911. Postpaid, \$4.22.

The present volume is undoubtedly the most important general work on the gymnosperms which has ever appeared and is highly creditable to American science. It consists of four hundred and fifty pages and of an equal number of, for the most part, original and remarkably good illustrations. The book is characterized throughout by a sane, broad and withal interesting treatment. The views expressed as to affinities and evolutionary sequence are for the most part clearly, logically and convincingly stated.

The volume is modeled on evolutionary lines, grounded on the solid foundation of the testimony afforded by the rocks, and in this respect presents an agreeable contrast to most

botanical works on plant evolution, which are too often written by persons who have no knowledge or appreciation of the past history of plants. In accordance with this feature, it begins with the oldest known seed-plants, the Cycadofilicales as the authors more logically term the Cycadofilices of Potonie and the Pteridospermeæ of Oliver and Scott. The enormous progress made in our knowledge of the evolution of the gymnosperms is nowhere better illustrated than in this chapter, which may be instructively compared with the meager amount of information supplied on the same subject in the first edition published ten years ago. Here we find an extremely good account of this fascinating primitive group of gymnosperms, long mistaken for ferns, whose true affinities were guessed at by the German paleobotanist Potonie and proved by Oliver, Scott, Grand'Eury and David White.

Logically following the Cycadofilicales, with the interposition of the Cordaitales, which need not be specially referred to in this connection, come the true Cycads and their allies the Bennettiales. The Chicago laboratories have added much to our knowledge of the Cycadales, and the chapter on this group of gymnosperms, now confined to the warmer regions near the equator, is one of the strongest in the book. The Bennettiales, the Cycads of the earlier Mesozoic, owe their elucidation to a large extent to the striking investigations of Dr. Wieland, of Yale University. We find them treated with the fulness which their importance demands.

Next to the Cycad-like gymnosperms come the relatives of the maidenhair tree, Ginkgo, sole survivor, through the pious care of the Japanese priests, of a stock which in the Mesozoic flourished abundantly throughout the northern hemisphere.

The Conifers, the most abundant and important gymnosperms of our existing flora and of great evolutionary importance on account of their extension into the remote past, appropriately occupy about one third of the volume. The gametophytes of this group, which have been particularly the subject of

investigation at Chicago, naturally come in for full consideration, but the past history and the important anatomical features of the Coniferales have not been overlooked. The great influence of modern anatomical and paleobotanical work is nowhere more clearly shown than in the systematic grouping of the Conifers along evolutionary lines. One illustration will serve to make this clear. In the first edition of the present work, which appeared ten years ago, the pine was considered to represent the highest member of the Conifers on account of the complexity of its vegetative and reproductive structures. In the present edition, it is put near the bottom, if not at the very bottom, of the coniferous series, since recent investigations, paleobotanical and anatomical, have demonstrated its great antiquity and at the same time the truth of the general proposition that the Conifers are a reduction series in which the simplest members are most modern and not an ascending one, in which the most complex representatives are the highest.

The Gnetales, which on account of their supposed affinities with the angiosperms are of great botanical interest, are adequately treated. The riddle of their existence is discussed in an entirely unpartisan manner. Following this chapter is one on evolutionary tendencies among the Gymnosperms. This part of the volume is naturally the one about which there is the greatest room for difference of opinion, and it is precisely here that the authors deserve the highest praise. At the present moment the older morphology is in process of resolution under the influence of experimental and paleobotanical activities. For that reason a clear expression of evolutionary sequence, even of groups concerning the past history of which we are well informed, as is relatively true of the Gymnosperms, is extremely difficult. Notwithstanding, in the present volume, we find a remarkably clear position taken, although not entirely unaffected by the back eddies resulting from the partial persistence of the older standpoints.

E. C. JEFFREY

HARVARD UNIVERSITY

Pharmaceutical Bacteria, with Special Reference to Disinfection and Sterilization. By ALBERT SCHNEIDER, M.D., Ph.D. Published by P. Blakiston's Son & Co., Philadelphia, Pa. Price \$2.00.

The rapid development of bacteriology in various directions has led to the publication of books in considerable number, showing the application of bacteriology to different phases of modern life. Medical bacteriology, agricultural bacteriology, industrial bacteriology and various other aspects of this new science have been fairly well exploited. The present book is in a new line, and is designed simply to cover the relations of bacteriology to pharmacy—being intended primarily for students in college of pharmacy and incidentally to pharmacists in general. The subjects that are treated in the work are only those which have some practical relation to this business. After a general introduction there is a brief but comprehensive historical survey of the development of bacteriology, divided into periods and bringing the subject up to date. This is followed by a general description and classification of bacteria, with the method of bacteriological technique, and then brief considerations of the relation of the bacteria to a few industries, like agriculture in general, dairying, the extermination of pests, canning, cider-making, etc. A somewhat extended discussion of the problems of immunity and the activities of bacterial products, together with a discussion of the manufacture of sera and vaccines, is naturally given in a book of this nature, the subject being treated from both a theoretical and a practical standpoint. Disinfection and the use of various disinfectants are discussed quite extensively, the subject being considered from the standpoint of the disinfection of water, of food, of dwelling houses, of surgeons' supplies, of various chemicals that are liable to be handled in the pharmacy; in short, all relations of disinfection which have a bearing upon the problems of the pharmacy, are carefully considered. A chapter upon communicable diseases and their prevention treats very briefly of the

better-known bacterial diseases and the most modern preventive methods; and lastly a suggestion is given for the equipment of a moderate sized laboratory for the pharmacy.

The book in general is well written, well illustrated, and will be useful for the people for whom it is particularly designed. As a book on bacteriology for the general student, however, it is too narrow in its scope to be of any great value or interest. As its title indicates, it is a pharmaceutical bacteriology, and its place is simply in schools of pharmacy and in the hands of pharmacists.

H. W. C.

The American Year Book. 1911. Edited by FRANCIS G. WICKWARE, B.A., B.Sc. New York, D. Appleton & Co.

The American Year Book in its second issue presents a carefully collected and compiled record of events and progress, largely with reference to the year 1911. There are here gathered facts of use to writers of many kinds, covering many fields, scientific, somewhat aside from science, like history and politics, and others into which science is to-day entering, like economics and the social questions. Industries and occupations are considered under a number of grouped heads, while the sciences themselves and engineering are ranged in some seven groups. There follow the humanities, an epitome of chronology and necrology and some references to the volume of 1910, which, being the first, reviewed and outlined a number of subjects.

There are two criteria for determining the quality of a volume like this; one its actual fitness for the purpose for which it is intended and the other the list of contributors. The first-named can be reliable only after a season of trial, and the excellences or demerits may not be apparent on cursory inspection. Taking the list of names of the authors of the various essays, they should stand for a superlative product. It was Dr. Walter Wyman who prepared the article on Public Health and Hygiene, the revision after his death being done by Dr. Schereschewsky.

There are here reviewed the world movements of epidemic diseases and the incidence and movements of the same within the United States. The writer does not fail to note in an authoritative way the measures of defense against the threatened invasion of cholera during the year, the unusual prevalence of smallpox, the improvement in the mortality rate of tuberculosis, the story of anti-typhoid vaccination, not forgetting a word of warning against measles and other diseases so common that no one fears them, yet which take large toll. In this connection it is interesting to note that the infant mortality can be given for eight states, only, Michigan being the sole one away from the Atlantic coast in which the registration is sufficiently good.

International statistics for world and country are presented from authoritative sources, government reports, local bulletins and the like. Some of the items are populations, national revenues and expenditures, products like cotton and wool, grains, coal and iron. These will be invaluable to persons needing such data. The international mortality rates given in the first grouping of figures is from an English source, the Registrar General's Annual Summary. It is curious that while taking places of as low rank in point of population as Stockholm and Bucharest, Prague, Trieste and Melbourne, the latter somewhere not far above 100,000, there are omitted such places as Tokio, Buenos Ayres, Liverpool, Warsaw, Manchester, Naples, etc., so that only about one third of the cities above half a million are represented. There must be better sources than that selected if full information is desired.

The third group, the Problems of Population, takes up many matters, one interesting one being the change in the shape of the head noticeable among the children of immigrants. For history there is a résumé of the political parties and their changes, some words on reciprocity and the tariff; conservation is considered and trusts and court decisions affecting corporations, etc. There is a good deal of space devoted to foreign history. Govern-

ment, national, state and municipal conditions are discussed at length; there is a consideration of economic conditions and labor questions, the items thus far occupying about half the bulky volume.

In matters of science the treatment is of rather restricted divisions, generally by those in the employ of the government or with colleges. In agriculture, Allen, Hooker, Evans, Knight and Glasson, all of them related to some bureau, discuss, respectively, the census of 1911, diseases of live stock, diseases of plants, legislation and horticulture, while Morse, of the Bussey Institute, considers live stock, and Felt, of Albany, the seventeen-year locust. Ethel Marion Smith, of the Bureau of Fisheries, takes up briefly the story of the fisheries. In similar manner Locke and Wilson, of the Massachusetts Institute of Technology, present reviews of mining and ore-dressing and coal, coke and petroleum, while Hofman, of the same school, discusses lead. Here no government expert is heard, but Fulton, president of the South Dakota school, Macgregor, of Columbia, and two engineers and an editor, Stoughton, Fulton and Ingalls, contribute other special articles. Mathematics in general is from the pen of Wilson, of the Massachusetts Tech, while Todd, of Amherst, writes quite at length and in an interesting manner of the astronomical world, outlining the important movements of the science. Geological topics are divided between Woodworth and Palache, of Harvard, Reid, of Johns Hopkins, who discusses vulcanology and De Wolf and Ransome. Meteorology of course is considered by Ward, of Harvard, terrestrial magnetism by Faris, in government employ, and in geography, Davis, of Harvard, is the only college man, Gannett and Littlehales, of Washington, and Adams, editor of the publications of the American Geographical Society, caring for the other sections. Chemistry enlists a full company of experts, Cornell and Columbia tying the government number, two, with one each from Technology and Wisconsin, while the story of physics is presented by Saunders, of Syracuse. In the same way are taken up zoology, botany, paleontology, eth-

nology and archeology, the last three together by the presentation of abstracts of the books, publications and society achievements of the year. These notings will serve to show the method in which the subjects are attacked and the kind of men who have contributed the different essays. Psychology and philosophy, medicine and surgery and engineering follow, while religion, the arts and literature round out the whole.

The book is of convenient size, 8vo, well printed on light-weight paper, so that it is—despite its bulk of 900 pages—not inconvenient to hold in the hand, and it is quite well indexed by larger topics, which will probably serve the purpose since the articles are in general not long and are arranged with well-displayed headings.

JOHN RITCHIE, JR.

NOTES ON METEOROLOGY AND CLIMATOLOGY

A NEW AEROLOGICAL LABORATORY

THE close relationship between meteorology, the science, and aviation, the art, is becoming more generally recognized as time progresses. At present there is being erected at Rostock, a small city in northern Germany, on an arm of the Baltic Sea, an institution which is to be an aerological observatory as well as an aeronautical laboratory. The aerological researches will be based upon data obtained from aloft by means of kites and balloons, while the aeronautical experiments will consist mainly of the adaptation of aircraft to the conditions thus determined. Professor Otto Krümmel will direct the aerological investigations, while Captain Alfred Hildebrandt will have charge of the aeronautical work, which will include a manufacturing plant. Because of the favorable location especial attention will be paid to hydro-aeroplanes. As is customary in Germany, municipal aid will be given the new institution.

THE NEW YORK METEOROLOGICAL OBSERVATORY

THE New York Meteorological Observatory, located in Central Park, New York City, has

recently been placed under the supervision of the U. S. Weather Bureau. This institution, the first in the country to be equipped with self-recording meteorological instruments, was founded by Daniel Draper, Ph.D., in 1868. The expense of conducting the work of the observatory was provided for by municipal appropriations, while the founder remained the active director until his retirement a year ago. The meteorological record, exceeding in length that of the Signal Service and Weather Bureau, has been constantly referred to by a variety of interests in the development of the American metropolis. Under the new arrangement the Weather Bureau has two observatories in New York City. At the Central Park station observations are taken for the city by the federal officials just as was done when it was entirely under city supervision.

ICE STORMS

WHEN rain falls while the temperature of the lower air is below freezing the drops solidify immediately after striking solid objects, and we have an ice storm—a frequent occurrence in the northeastern part of the United States. The precipitation continues in the form of rain when the temperature of the air near the ground is sometimes as low as 9° F., showing that there must be an inversion stratum but a short distance aloft, otherwise the condensation would result in the formation of solid particles rather than liquid drops. In New England, where these storms are particularly frequent, it is not uncommon for the ice to accumulate to a depth of an inch on all exposed objects, and on one occasion, February 14-16, 1909, ice was thus formed to a thickness of three inches in the suburbs of Boston, and did not disappear until four days after the storm had ended. The supposition that there is a relatively warm stratum aloft during an ice storm was verified by means of a kite flight at Blue Hill Observatory on March 7 last. In that flight the auxiliary kites added to lift the line became so heavily coated with ice that they pulled the leading kite down instead of aiding in its

ascent, thereby rendering the maximum height reached during the flight considerably lower than usual. It was found that the air was practically isothermal from the summit of Blue Hill (200 meters above sea-level) to 625 meters above sea-level, the temperature being about 30.8° F. Beyond the latter level, however, the temperature increased steadily with height, and was 36.8° F. at 874 meters, the maximum height reached by the meteorograph. Raindrops falling from this relatively warm stratum were undercooled by their passage through the colder air below, and immediately changed to ice upon striking solid objects.

EXTREME COLD IN THE UNITED STATES

In persistence and severity the cold experienced in the central and eastern parts of the United States during January and February is noteworthy, as is seen from the following: At Grand Forks, N. D., the temperature fell to zero or below every day of January except the last, the lowest temperatures for all the days of the month averaging —20.0° F. At Washta, Iowa, —47° was officially recorded January 12. At Chicago, Ill., where the average daily deficiency was 11.9° F. the month was the coldest since the establishment of the Signal Service station there in 1871, and in unofficial records prior to 1871, extending back to 1830, the coldest January was 1.4° warmer than that of 1912. The mercury fell to zero or lower on 13 days, 10 of these being consecutive, and was continuously below zero for 79 hours during the 3d-7th, the longest period on record there. At Washington, D. C., usually a place of mild winter weather, —14° was recorded January 14, this reading being within 1° of the lowest temperature officially recorded there in 42 years, which is the length of the record. Some results of the extreme cold were unprecedented. For the first time since white man has lived in its vicinity Lake Superior was frozen over from shore to shore, the ice being of sufficient thickness to allow moose to cross from Canada to the American shore, according to press dispatches. For the first time in 28 years ice completely spanned Lake Michigan in places

on February 10. Lake Erie was also frozen completely across in some places. Since 1885 Cayuga Lake, in New York State, has not been frozen from end to end until last winter. Many important harbors along the Atlantic coast were kept open only by the ceaseless work of ice-breaking vessels, and for more than a week Long Island Sound was ice-covered, except for the narrow lane kept open by the frequent passage of steamers. Fire losses in the United States for the six weeks ending February 17 were the heaviest for a period of that length in the history of American underwriting, barring periods in which notable conflagrations occurred. The losses for January, 1912, were 67 per cent. greater than those of the same month a year ago, and 134 per cent. greater than those of two years ago. These facts are explained by underwriters as being largely due to frozen water-mains and hydrants, and to snow-blockaded streets, which handicapped the firemen. Doubtless the "oldest inhabitant" can recall many winters which were accompanied by considerably heavier snowfall, severer and more frequent storms and higher and more destructive winds than those just experienced, but few there are probably who can remember a longer period of frigid temperatures, with results similar to those cited.

WINTER WEATHER IN FLORIDA

FLORIDA, widely advertised as having "perpetual summer," or as one railroad puts it, "where every day is a June day," has been generally regarded as having a fountain of perpetual something or other ever since the days of Ponce de Leon. Its real climate, however, did not receive careful attention until large numbers of settlers were attracted by the recent land-boom. In A. J. Henry's "Climatology of the United States" it is stated that in 1886 and 1894 frost destroyed practically all citrus fruits in the state, and in 1895 and 1899 trees in the northern counties were killed in that manner. During the past century there have been at least seven severe freezes in the state, during two of which, 1835 and 1899, practically a zero temperature prevailed over the interior of the

northern and western counties. Snow has fallen over the greater portion of the state, and on February 7, 1835, when a temperature of 7° above zero was recorded in Jacksonville, the St. John's River was frozen. A temperature of -2° F. has been recorded within the state. In all but eight of the last seventy years freezing temperatures have occurred in Jacksonville. January last, an extremely cold month over much of the United States, was also severe in Florida. The isotherm of freezing reached as far south as the middle of the peninsula on the 16th. At Miami, latitude 26° N., the most southerly city on the mainland of the United States, frost was recorded on February 11. As a winter resort contrast Florida with certain parts of California. According to official reports, 42° F. was the lowest temperature recorded during January at both San Francisco and Los Angeles.

A STORM DETECTOR

REFERENCE has already been made in these notes¹ to the use of a wireless telegraph receiver to detect the approach of storms through the waves set up by electrical discharges. The idea was taken up by M. Flageolet, who has just invented an instrument of such acute sensitiveness that it records a storm at a distance of 300 miles. As it usually takes a storm about a day to travel this distance, the practical importance of the new invention will be considerable. The instrument was recently demonstrated before the Academy of Sciences in Paris by M. Violle.

THE DISTRIBUTION OF RAIN IN CYCLONES

THE distribution of rain in cyclonic storms has long been a problem of interest to meteorologists. As yet, however, all do not agree as to the region of heaviest precipitation with reference to the storm center. From early investigations it appeared that the rainfall was heaviest near the center of the depression, and became less and less toward the sides. Observations made at Blue Hill Observatory showed that clouds were densest and most fre-

¹ SCIENCE, Vol. XXXI., No. 807, June 17, 1910, p. 952.

quent in the southeast quadrant of a depression. Professor Waldo ("Elementary Meteorology," p. 221) says:

In the eastern and northern parts of the United States the area of maximum rainfall lies southeast of the center of the cyclone, and usually at a distance of about 300 miles from it; but the distance varies greatly in individual instances.

In New England, however, the rainfall seems to be heaviest in the northeast quadrant of a cyclone, the precipitation accompanying a "northeaster," in which the center of the depression remains south of the observer during its eastward movement, is usually heavier than that of a storm whose center passes down the St. Lawrence Valley. Dr. Shaw ("Forecasting Weather," p. 206) seems to be of the opinion that the precipitation is most abundant, or at least is most frequent, in the "left front of the depression." In the latest discussion of the problem, Mr. F. J. Wardale (*Symonds's Meteorological Magazine*, February, 1912, p. 8) concludes that when a depression crosses England the bulk of the rain falls in subsidiary eddies on its northern side, the region of heaviest precipitation as the storm advances being "a broken band parallel to or gradually diverging from the central track on its left side." He believes that these eddies, too shallow to be evidenced on the meteorological charts, have a counter-clockwise orbital movement around their primary, at the same time sharing its forward movement. These eddies, in which the heavier downpours occur, pass quickly over and hence give slight precipitation to a place south of the storm track, for there they are accelerated by the general forward movement. For a place to the north of the center, the orbital velocity of the secondary is subtracted from the general forward movement, consequently the eddy passes slowly and in some cases might remain stationary, resulting in prolonged and therefore heavy rain. These eddies, he believes, are formed at intervals during the progress of the cyclone, thus accounting for the patchiness of the band of high rainfall. Mr. Wardale's suggestions are well worth the serious consideration of forecasters, since unno-

ticed secondaries and trough-like isobars have often resulted in heavy precipitation when fair weather was expected. His conclusions agree closely with those previously reached by Mr. W. G. Reed in a study of the cyclonic distribution of rainfall in the United States (*Monthly Weather Review*, October, 1911, p. 1609).

NEW BOOKS

AMONG the books which have recently appeared are: (1) "Meteorology," by W. I. Milham. New York, The Macmillan Co. 8vo. 549 pp. \$4.50 net. (2) "Weather Signs and How to Read Them, for Use at Sea," by W. Allingham. Glasgow, J. Brown & Son. 117 pp. 2s. net. (3) "The Sun," by C. G. Abbot. New York, D. Appleton & Co. 448 pp. (4) "Über die Helligkeit des Himmels in der Nahe der Sonne," by H. Diercks. Kiel, Lüdtke & Martens. 48 pp. (5) "Über die Gesetz der Wärmestrahlung," by W. Wien. Leipzig, J. A. Barth. 21 pp. 1 Mark. Among the books soon to appear are: (1) "The Meteorology of the Globe," by W. N. Shaw. (2) "Clouds," by C. T. R. Wilson. (3) "Structure of the Atmosphere," by C. J. P. Cave. (4) "Weather-science," by G. F. K. Lempfert. (5) "Radiation," by P. Phillips. Professor R. DeC. Ward has begun the preparation of a "Climatology of the United States."

ANDREW H. PALMER

BLUE HILL OBSERVATORY,

May 1, 1912

SPECIAL ARTICLES

THE ORIGIN OF ERYTHROCYTES BY A PROCESS OF CONSTRICTION OR BUDDING

It is gradually becoming apparent that in the solution of some of the more intricate morphological problems, involving phenomena of development and histogenesis, recourse will be necessary, in part at least, to data other than those obtained from fixed and stained preparations alone. Sabin, '05, in a discussion of evidence from fixed histological material bearing on certain questions regarding lymph-

ocytes and lymph glands has well expressed this conviction in the conclusion that "we must await some new method of attacking the problem." The recent development in the technique of tissue culture, with the striking results obtained by Harrison, Burrows, Lewis, Loeb and others, leads one to expect that similar methods may yield important data concerning the complicated problem of the life history and genetic relationship of the various types of blood cells. With this hope a study of the behavior of blood corpuscles in plasma cultures was begun somewhat over a year ago. Some of the results regarding the red blood cells appear of sufficient importance to justify a preliminary statement.

The present observations relate to the origin of the erythrocytes or non-nucleated red blood corpuscles and bear directly upon the longstanding question of the elimination of the nucleus. The description will be confined to certain results reached in a study of the blood of the pig embryo. Stating the method briefly, the erythroblasts of the embryonic blood were taken at various stages of differentiation and observed in hanging-drop cultures, employing the technique devised by Harrison and Burrows, with such modifications as appeared essential for the present purpose. Biased by the prevalent view that the nucleus of the erythroblast subsequently disappears, either by disintegration or by extrusion, it was hoped that it might be possible to observe the process directly in the living cell. It can be readily appreciated then with what surprise it was discovered that erythrocytes may arise in a manner fundamentally different from either of the above alternatives.

During the first half day (circumstances necessitated beginning the cultures in the afternoon) the erythroblasts manifest a variety of cytoplasmic activities, not inadequately described as amoeboid in character. Numerous pseudopodia-like projections of various types are present. The greater number are in the form of tapering points or slender, elongated processes, varying from one to several in a given erythroblast. In a smaller number of cases the cytoplasm extends out in

blunt, rounded, somewhat bud-like projections. These processes manifest constant quivering and oscillating movements. Other erythroblasts, spherical in form, are more or less quiescent. During the second day, of the above types of processes, the blunt bud-like form has become much more predominant. In other respects the cells appear as on the preceding day. These bud-like processes may involve one third or even more than one half of the cytoplasm of the cells. A striking feature is that not only are the buds completely filled with hemoglobin, but in many cases practically the entire hemoglobin content of the erythroblast has become segregated in the bud, leaving a more or less clear and hemoglobin-free cytoplasmic area surrounding the nucleus. If observations are begun upon the cell at this stage, the bud will be found in a state of amoeboid activity manifested in changes in the contour varying from slight modifications to elongated projections. If the cell is at the height of its activity an astonishing thing may now occur: a constriction becomes evident and within a few minutes or even seconds this constriction is completed and the hemoglobin-containing bud is liberated from the cell. Typically this liberated bud corresponds in size and appearance with the adjacent erythrocytes; it may assume a bi-concave disc shape, and in one instance it was possible to continue the observations sufficiently to follow the final transformation of the liberated bud beyond this disc shape to a typical cup-shaped form. In each case control specimens of the blood originally employed for the cultures were fixed in formalin vapor and stained. Budding erythroblasts were also successfully fixed and stained and were found to correspond both in their cytoplasmic and nuclear characteristics with the control specimen. Erythroblasts were maintained in normal condition in several experiments for three or more days. Budding activities were continuous throughout this time, and under favorable conditions ten or more cells in various stages of active budding could be counted in a given field of the microscope.

When these remarkable activities were first observed it seemed incredible that we were witnessing a normal mode of erythrocyte formation. The experiments were consequently repeated many times, subjected to various tests, and the results analyzed in the light of all the criticism that could be brought to bear upon the subject. Temperature, media, evaporation, staining reaction and degenerative changes have been carefully considered. It is a pleasure to state that Professor R. J. Terry and Mr. C. H. Danforth, of the anatomical department, have also carefully followed these erythroblast activities and have kindly subjected the results to valuable criticism. In brief, after careful study the conclusion seems unavoidable that we are here confronted with a *normal mode of formation of mammalian erythrocytes by a process of budding and constriction from the parent erythroblast*. It is interesting that this result is in accord with the discarded theory of Malassez (1882), on the origin of erythrocytes from bone marrow cells by budding, while at the same time the investigations were made and the conclusions drawn entirely independent of any previous knowledge of his work.

In addition to the formation of typical erythrocytes, another type of activity consists in the production of either very small buds or slender, elongated, rod-like processes which may ultimately segment into a varying number of subdivisions about one third or one fourth the size of the average erythrocyte. These correspond very closely in size and form to blood platelets. As for the amount of cytoplasm remaining with the nucleus, after the constriction off of an erythrocyte, it may vary from a small rim about the nucleus to a quantity occasionally even larger than the erythrocyte to which the parent cell has given rise. No conclusive evidence of a migration of the nucleus from the cell has as yet been obtained. However, in the case of the smaller erythroblasts the constriction may take place so close to the nucleus that it may present the appearance of nuclear extrusion, and it is readily conceivable

that in some cases the constriction may be such as to leave behind a practically cytoplasmic-free nucleus and thus account for the free erythrocytic nuclei occasionally found in the blood. That the fundamental process here described is one of cytoplasmic constriction rather than of nuclear extrusion is still further demonstrated by the fact that occasionally a single large erythroblast was observed to give rise to even two buds, both of which became detached from the parent cell.

Granting that we are justified in the above conclusion, various questions naturally present themselves; among others the behavior of the erythroblasts in different media; the factors involved in the formation of hemoglobin and its separation from the erythroblast; the subsequent assumption by the liberated globule of a disc or cup-shaped form; the fate of the nucleated remainder of the erythroblast, and the possible relationship between lymphocytes and erythroblasts. Investigation bearing on these problems is under way. The present preliminary statement will be followed as soon as possible with a full description of technique, detailed data, and figures upon which these conclusions are based.

V. E. EMMEL

DEPARTMENT OF ANATOMY,
WASHINGTON UNIVERSITY MEDICAL SCHOOL,
April 25, 1912

ON THE APPEARANCE OF ALBINO MUTANTS IN
LITTERS OF THE COMMON NORWAY RAT,
MUS NORVEGICUS

AFTER several failures to breed the Norway rats in cages, we have finally succeeded in raising them in captivity by means of an improvement in the cages and diet, as well as in general treatment.

This successful experiment was begun more than two years ago and we are just getting the litters which belong to the third generation born in captivity. It may be added that in all cases the brothers and sisters of the same litters were mated as I wished to determine the combined effects of close inbreeding and captivity.

The total number of rats belonging to the third generation born in captivity is not yet large. There are, however, six litters altogether, each having a different parentage. Within these six litters I have found four pure albino rats (white coat and pink eyes) among only brown-coated brothers and sisters. The distribution of these albino mutants within the litters is as follows:

- (1) 7 brown and no albinos, born March 15, 1912.
- (2) 6 brown and no albinos, born March —, 1912.
- (3) 4 brown and 3 albinos, born April 17, 1912.
- (4) 4 brown and 1 albino, born April 17, 1912.
- (5) 12 brown and no albinos, born April 30, 1912.
- (6) 5 brown and no albinos, born May 4, 1912.

This litter was found dead; all had pigmented eyes.

Thus the number of albino mutants in proportion to the brown-coated brothers and sisters is not large, though it may increase in subsequent generations. Although I have been anticipating that such albino mutants might occur sometime, nevertheless it was a great surprise to obtain them within so few generations.

So far as I am aware, this is the first instance in which the albino mutants have been obtained from the common Norway rats under laboratory conditions and I thought the event of sufficient interest to justify this note.

S. HATAI

THE WISTAR INSTITUTE

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and fifty-eighth regular meeting of the Society was held at Columbia University on Saturday, April 27, 1912, with an attendance of fifty-two members. President H. B. Fine occupied the chair. The following new members were elected: Miss S. R. Benedict, Smith College; Mr. C. E. Fisher, Rhode Island Normal School; Dr. T. H. Gronwall, Chicago, Ill.; Mr. Louis A. Hopkins, University of Michigan; Dr. A. J. Kemper, University of Illinois; Mr. V. C. Poor, University of Michigan; Mr. R. B. Stone, Harvard University; Mr. K. P. Williams, Princeton University. Seven applications for membership in the society were received.

It was decided to hold the annual meeting this year at Cleveland, Ohio, in affiliation with the American Association for the Advancement of Science. The winter meeting of the Chicago Section will be merged in this general meeting of the society. Owing to President Fine's absence abroad, his presidential address will not be delivered at this meeting but at the annual meeting of 1913.

The following papers were read at the April meeting:

R. L. Moore: "Concerning Jordan curves in non-metrical analysis situs."

J. K. Lamond: "Improper multiple integrals over iterable fields."

L. A. Howland: "Binary conditions for singular points on a cubic."

B. H. Camp: "Certain integrals containing parameters."

S. Lefschetz: "On the V_3^3 with five nodes of the second species in S_4 ."

E. R. Marshall: "A labor-saving device in computation."

G. D. Birkhoff: "The reducibility of maps."

G. D. Birkhoff: "A determinant formula for the number of ways of coloring any map."

Oswald Veblen: "An application of modular equations in analysis situs."

H. B. Phillips and C. L. E. Moore: "A geometric use of matrices."

H. B. Phillips and C. L. E. Moore: "A theory of linear distance and angle."

L. P. Siceloff: "Sylow subgroups of groups whose orders are of certain special forms."

A. D. Pitcher: "Concerning the continuity and convergence of functions of a general variable."

W. R. Longley: "Proof of a theorem due to Picard."

A. R. Schweitzer: "Remark on a functional equation."

A. R. Schweitzer: "Theorems on functional equations."

Dunham Jackson: "On approximation by trigonometric sums and polynomials (second paper)."

N. J. Lennes: "Concerning Van Vleck's non-measurable set."

N. J. Lennes: "Concerning infinite polygons and polyhedrons."

The next meeting of the society will be the summer meeting, which will be held at the University of Pennsylvania, September 10-11.

F. N. COLE,
Secretary

SCIENCE

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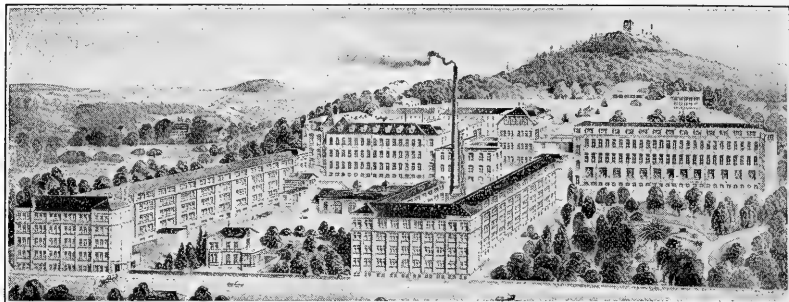
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Increase in Efficiency. The ever-increasing demand for our microscopes, etc., naturally means an accordingly large output, and we desire to impress on the minds of our patrons that the well regulated system in our factory makes it impossible for the precision in optical and mechanical workmanship to suffer. (This cannot be said of factories where the so-called automatic system of turning out instruments is adopted.) Our Scientific Departments are unceasingly devoting their efforts to increase optical and mechanical precision.

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In closing we wish to extend our sincere thanks for the confidence placed in us by our many friends, and await opportunity to reciprocate when next you call upon us to serve you.

U. S.
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SCIENCE

FRIDAY, JUNE 7, 1912

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

SOME THOUGHTS ON MODERN MATHEMATICAL RESEARCH¹

MATHEMATICS has a large household and there are always rumors of prospective additions despite her age and her supposed austerity. Without aiming to give a complete list of the names of the members of this household we may recall here a few of the most prominent ones. Among those which antedate the beginning of the christian era are surveying, spherical astronomy, general mechanics and mathematical optics. Among the most thriving younger members are celestial mechanics, thermodynamics, mathematical electricity and molecular physics.

Usually a large household serves as one of the strongest incentives to activity, and mathematics has always responded heartily to this incentive. As the most efficient continued service calls for unusual force and ingenuity, mathematics has had to provide for her own development and proper nourishment in addition to providing as liberally as possible for her household. This double object must be kept prominently before our eyes if we would comprehend the present mathematical activities and tendencies.

There is another important incentive to mathematical activity which should be mentioned in this connection. Mathematics has been very hospitable to a large number of other sciences and as a consequence some of these sciences have become such frequent visitors that it is often difficult to distinguish them from the regular members of the household. Among these visitors are

¹ Read before the Illinois Chapter of the Society of the Sigma Xi, April, 1912.

economics, dynamical geology, dynamical meteorology and the statistical parts of various biological sciences. Visitors usually expect the best that can be provided for them, and the efforts to please them frequently lead to a more careful study of available resources than those which are put forth in providing for the regular household.

We have thus far spoken only of what might be called the materialistic incentives for mathematical development. While these have always been very significant, it is doubtful whether they have been the most powerful. Symmetry, harmony and elegance of form have always appealed powerfully to dame mathematics; and a keen curiosity, fanned into an intense flame by little bits of apparently incoherent information, has inspired some of the most arduous and prolonged researches. Incentives of this kind have led to the *mathematics of the invisible*, relating to refinements which are essentially foreign to counting and measuring. The first important refinement of this type relates to the concept of the irrational, introduced by the ancient Greeks. As an instance of a comparatively recent development along this line we may mention the work based upon Dedekind's definition of an infinite aggregate as one in which a part is similar or equivalent to the whole.²

Mathematics is commonly divided into two parts called pure and applied, respectively. It should be observed that there are various degrees of purity and it is very difficult to say where mathematics becomes sufficiently impure to be called applied. The engineer or the physicist may reduce his problem to a differential equation, the student of differential equations may reduce his troubles to a question of function

theory or geometry, and the workers in the latter fields find that many of their difficulties reduce themselves to questions in number theory³ or in higher algebra. Just as the student of applied mathematics can not have too thorough a training in the pure mathematics upon which the applications are based so the student of some parts of the so-called pure mathematics can not get too thorough a training in the basic subjects of this field.

As mathematics is such an old science and as there is such a close relation between various fields, it might be supposed that fields of research would lie in remote and almost inaccessible parts of this subject. It must be confessed that this view is not without some foundation, but these are days of rapid transportation and the student starts early on his mathematical journey. The question as regards the extent of explored country which should be studied before entering unexplored regions is a very perplexing one. A lifetime would not suffice to become acquainted with all the known fields, and there are those who are so much attracted by the explored regions that they do not find time or courage to enter into the unknown.

In 1840 C. G. J. Jacobi used an illustration, in a letter⁴ to his brother, which may serve to emphasize an important point. He states that at various times he had tried to persuade a young man to begin research in mathematics, but this young man always excused himself on the ground that he did not yet know enough. In answer to this statement Jacobi asked this man the following question: Suppose your family would wish you to marry, would you then

² "Der Urquell aller Mathematik sind die ganzen Zahlen, Minkowski, Diophantische Approximation," 1907, preface.

⁴ "Briefwechsel zwischen C. G. J. Jacobi und M. H. Jacobi," 1907, p. 64.

² "Encyclopédie des sciences mathématiques," Vol. I., part 1, 1904, p. 2.

also reply that you did not see how you could marry now, as you had not yet become acquainted with *all* the young ladies?

In connection with this remark by Jacobi we may recall a remark by another prominent German mathematician who also compared the choice of a subject of research with marriage. In the "Festschrift zur Feier des 100 Geburtstages Eduard Kummers," 1910, page 17, Professor Hensel states that Kummer declined, as a matter of principle, to assign to students a subject for a doctor's thesis, saying that this would seem to him as if a young man would ask him to recommend to him a pretty young lady whom he should marry.

While it may not be profitable to follow these analogies into details, it should be stated that the extent to which a subject has been developed does not necessarily affect adversely its desirability as a field of research. The greater the extent of the development the more frontier regions will become exposed. The main question is whether the new regions which lie just beyond the frontier are fertile or barren. This question is much more important than the one which relates to the distance that must be traveled to reach these new fields. Moreover, it should be remembered that mathematics is n -dimensional, n being an arbitrary positive integer, and hence she is not limited, in her progress, to the directions suggested by our experiences.

If we agree with Minkowski that the integers are the source of all mathematics⁵ we should remember that the numbers which have gained a place among the integers of the mathematician have increased

⁵ This view was expressed earlier by Kronecker, who was the main founder of the school of mathematicians who aim to make the concept of the positive integers the only foundation of mathematics. Cf. Klein und Schimmack, "Der mathematische Unterricht an den hoeheren Schulen," 1907, p. 175.

wonderfully during recent times. According to the views of the people who preceded Gauss, and according to the elementary mathematics of the present day, the integers may be represented by points situated on a straight line and separated by definite fixed distance. On the other hand, the modern mathematician does not only fill up the straight line with algebraic integers, placing them so closely together that between any two of them there is another, but he fills up the whole plane equally closely with these integers. If our knowledge of mathematics had increased during the last two centuries as greatly as the number of integers of the mathematician we should be much beyond our present stage. The astronomers may be led to the conclusion that the universe is probably finite from the study of the number of stars revealed by telescopes of various powers, but the mathematician finds nothing which seems to contradict the view that his sphere of action is infinite.

From what precedes one would expect that the number of fields of mathematical research appears unlimited and this may serve to furnish a partial explanation of the fact that it seems impossible to give a complete definition of the term mathematics. If the above view is correct we have no reason to expect that a complete definition of this term will ever be possible, although it seems possible that a satisfactory definition of the developed parts may be forthcoming.⁶

Among the various fields of research those which surround a standing problem are perhaps most suitable for a popular exposition, but it should not be inferred that these are necessarily the most important points of attack for the young inves-

⁶ Bôcher discussed some of the proposed definitions in the *Bulletin of the American Mathematical Society*, Vol. II. (1904), p. 115.

tigator. On the contrary, one of the chief differences between the great mathematician and the poor one is that the former can direct his students into fields which are likely to become well known in the near future, while the latter can only direct them to the well-known standing problems of the past, whose approaches have been tramped down solid by the feet of the mediocre, who are often even too stupid to realize their limitations. The best students can work their way through this hard crust, but the paddle of the weaker ones will only serve to increase its thickness if it happens to make any impression whatever.

It would not be difficult to furnish a long list of standing mathematical problems of more or less historic interest. Probably all would agree that the most popular one at the present time is Fermat's greater theorem. In fact, this theorem has become so popular that it takes courage to mention it before a strictly mathematical audience, but it does not appear to be out of place before a more general audience like this.

The ancient Egyptians knew that $3^2 + 4^2 = 5^2$ and the Hindus knew several other such triplets of integers at least as early as the fourth century before the Christian era.⁷ These triplets constitute positive integral solutions of the equation

$$x^2 + y^2 = z^2.$$

Pythagoras gave a general rule by means of which one can find any desired number of such solutions, and hence these triplets are often called Pythagorean numbers. Another such rule was given by Plato, while Euclid and Diophantus generalized and extended these rules.

Fermat, a noted French mathematician of the seventeenth century, wrote on the

⁷ Lietzmann, "Der Pythagoreische Lehrsatz," 1912, p. 52.

margin of a page of his copy of Diophantus the theorem that it is impossible to find any positive integral solution of the equation

$$x^n + y^n = z^n \quad (n > 2).$$

He added that he had discovered a wonderful proof of this theorem, but that the margin of the page did not afford enough room to add it.⁸ This theorem has since become known as Fermat's greater theorem and has a most interesting and important history, which we proceed to sketch.

About a century after Fermat had noted this theorem Euler (1707-1783) proved it for all the cases when n is a multiple of either 3 or 4, and, during the following century, Dirichlet (1805-1859) and Legendre (1752-1833) proved it for all the cases when n is a multiple of 5. The most important step towards a general proof was taken by Kummer (1810-1893), who applied to this problem the modern theory of algebraic numbers and was thus able to prove its truth for all multiples of primes which do not exceed 100 and also for all the multiples of many larger primes.

The fact that such eminent mathematicians as Fermat, Euler, Dirichlet, Legendre and Kummer were greatly interested in this problem was sufficient to secure for it considerable prominence in mathematical literature, and several mathematicians, including Dickson, of Chicago, succeeded in extending materially some of the results indicated above. The circle of those taking an active interest in the problem was suddenly greatly enlarged, a few years ago, when it became known that a prize of 100,000 Marks (about \$25,000) was awaiting the one who could present the first complete solution. This amount was put in trust of the Göttingen Gesellschaft der

⁸ Fermat's words are as follows: "Cujus rei demonstrationem mirabilem sane detexi. Hanc marginis exiguitas non caperet."

Wissenschaften by the will of a deceased German mathematician named Wolfskehl, and it is to remain open for about a century, until 2007, unless some one should successfully solve the problem at an earlier date.

It is too early to determine whether the balance of the effects of this prize will tend towards real progress. One desirable feature is the fact that the interest on the money is being used from year to year to further important mathematical enterprises. A certain amount of this has already been given to A. Wieferich for results of importance towards the solution of Fermat's problem, and other amounts were employed to secure at Göttingen courses of lectures by Poincaré and Lorentz.

What appears as a bad effect of this offered prize is the fact that many people with very meager mathematical training and still less ability are wasting their time and money by working out and publishing supposed proofs. The number of these is already much beyond 1,000 and no one can foresee the extent to which this kind of literature will grow, especially if the complete solution will not be attained during the century. A great part of this waste would be eliminated if those who would like to test their ability along this line could be induced to read, before they offer their work for publication, the discussion of more than 100 supposed proofs whose errors are pointed out in a German mathematical magazine called *Archiv der Mathematik und Physik*, published by B. G. Teubner, of Leipzig. A very useful pamphlet dealing with this question is entitled, "Ueber das letzte Fermatische Theorem, von B. Lind," and was also published by B. G. Teubner, in 1910.

A possible good effect of the offered prize is that it may give rise to new developments and to new methods of attack. As

the most successful partial solution of the problem was due to the modern theory of algebraic numbers, one would naturally expect that further progress would be most likely to result from a further extension of this theory, or, possibly, from a still more powerful future theory of numbers. If such extensions will result from this offer they will go far to offset the bad effect noted above, and they may leave a decided surplus of good. Such a standing problem may also tend to lessen mathematical idolatry, which is one of the most serious barriers to real progress. We should welcome everything which tends to elevate the truth above our idols formed by men, institutions or books.

In view of the fact that the offered prize is about \$25,000 and that lack of marginal space in his copy of Diophantus was the reason given by Fermat for not communicating his proof, one might be tempted to wish that one could send credit for a dime back through the ages to Fermat and thus secure this coveted prize and the wonderful proof, if it actually existed. This might, however, result more seriously than one would at first suppose; for if Fermat had bought on credit a dime's worth of paper even during the year of his death, 1665, and if this bill had been drawing compound interest at the rate of six per cent. since that time, the bill would now amount to more than seven times as much as the prize. It would therefore require more than \$150,000, in addition to the amount of the prize, to settle this bill now.

While it is very desirable to be familiar with such standing problems as Fermat's theorem, they should generally be used by the young investigator as an indirect rather than as a direct object of research. Unity of purpose can probably not be secured in any better way than by keeping

in close touch with the masters of the past,⁹ and this unity of purpose is almost essential to secure real effective work in the immense field of mathematical endeavor. As a class of problems which are much more suitable for direct objects of research on the part of those who are not in close contact with a master in his field, we may mention the numerous prize subjects which are announced from year to year by foreign academies.

Among the learned societies which announce such subjects the Paris Academy of Sciences is probably most widely known, but there are many others of note. The subjects announced annually by these societies cover a wide range of mathematical interests, but they are frequently beyond the reach of the young investigator.¹⁰ It is very easy to obtain these subjects, since they generally appear in the "notes" of many mathematical journals. In our country the *Bulletin of the American Mathematical Society* is rendering very useful service along this and many other lines. While some of these subjects are very general, there are others which indicate clearly the particular difficulties which must be overcome before further progress in certain directions seems possible and hence these subjects deserve careful study, especially on the part of the younger investigators.

As long as one is completely guided, in selecting subjects for research, by the standing problems or by the subjects announced by learned bodies and those proposed individually by prominent investigators, one is on safe ground. Real progress along any of these lines is welcomed by our

⁹ Darboux, *Bulletin des Sciences Mathématiques*, Vol. 32 (1908), p. 107.

¹⁰ For solutions of such problems in pure mathematics by Americans, see *Bulletin of the American Mathematical Society*, Vol. 7 (1901), p. 190; Vol. 16 (1910), p. 267.

best journals, as such progress can easily be measured, and it fits into a general trend of thought which is easily accessible in view of the many developed avenues of approach. Notwithstanding these advantages, the real investigator should reach the time when he can select his own problems without advice or authority; when he feels free to look at the whole situation from a higher point of view and to assume the responsibility of an independent choice, irrespective of the fact that an independent choice may entail distrust and misgivings on the part of many who would have supported him nobly if he had remained on their plane.

In looking at the whole situation from this higher point of view many new and perplexing questions confront us. Why should the developments of the past have followed certain routes? What is the probability that the development of the territory lying between two such routes will exhibit new points of contact and greater unity in the whole development? What should be some guiding principles in selecting one rather than another subject of investigation? What explanation can we give for the fact that some regions bear evidences of great activity in the past but are now practically deserted, while others maintained or increased their relative popularity through all times?

One of the most important tests that can be applied to a particular mathematical theory is whether it serves as a unifying and clarifying principle of wide applications. Whether these applications relate to pure mathematics only or to related fields seems less important. In fact, the subjects of application may have to be developed. If this is the case, it is so much the better provided always that the realm of thought whose relations are exhibited by the theory is extensive and that the relations are of such a striking character as to

appeal to a large number of mathematical intellects of the present or of the future. Some isolated facts may be of great interest, but as long as they are isolated they have little or no real mathematical interest. One object of mathematics is to enable us to deal with infinite sets with the same ease and confidence as if they were individuals. In this way only can our finite mind treat systematically some of the infinite sets of objects of mathematical thought.

In comparatively recent years the spirit of organization has made itself felt among mathematicians with rapidly increasing power, and it has already led to many important results. Beginning with small informal organizations in which the social element was often most prominent, there have resulted large societies, national and even international, with formal organizations and with extensive publications. In reference to one of these early organizations, the mathematical society of Spitalfields in London, which lasted for more than a century (1717-1845), it is said that each member was expected to come to the meetings with his pipe, his mug and his problem.¹¹

The modern mathematical society is dominated by a different spirit. It generally supports at least one organ for publication, and scholarly publicity develops scholarly cooperation as well as scholarly ambitions. This cooperation has led to movements which could not have been undertaken by a few individuals. One may recall here the *Revue Semestrielle*, published under the auspices of the Amsterdam Mathematical Society; the extensive movement to examine and compare methods and courses of mathematical instruction in various countries,

inaugurated at the fourth international congress, held at Rome in 1908; and, especially the great mathematical encyclopedias whose start was largely influenced by the support of the deutschen Mathematiker-Vereinigung as expressed at the Vienna meeting in 1894. The French edition of the latter work, which is now in the course of publication, is expected to include thirty-four large volumes, besides those which are to be devoted to questions of the philosophy, the teaching and the history of mathematics.

These encyclopedias and other large works of reference are doing much to expedite travel in the mathematical field. In fact, it would probably not be exaggerating if we should say that by these encyclopedias alone the distances, in time and effort, between many points of the mathematical field have been cut in two. In this connection, it may be fitting to recall, with a deep sense of obligation, the great work which is being done by the Royal Society of London—not only for mathematics, but also for a large number of other sciences—in providing bibliographical aids on a large scale. If the increase in knowledge will always be attended by a corresponding increase in means to learn readily what is known, even the young investigator of the future will have no reason to regret the extent of the developments. On the contrary, these should make his task easier, since they furnish such a great richness of analogies and of tried methods of attack.

The last two or three decades have witnessed a great extension of mathematical research activity. As a result of this we have a large number of new mathematical societies. A few of the most recent ones are as follows: Calcutta Mathematical Society (1908), Manchester Mathematical Society (1908), Scandinavian Congress of Mathematicians (1909), Swiss Mathemat-

¹¹ "Es wurde von jedem erwartet, dass er seine Pfeife, seinen Krug und sein Problem mitbringe." Cantor, "Vorlesungen ueber Geschichte der Mathematik," Vol. 4, 1908, p. 59.

ical Society (1910), Spanish Mathematical Society (1911) and the Russian Congress of Mathematicians (1912). In Japan a new mathematical periodical, called *Tôhoku Mathematical Journal*, was started in 1911, and a few years earlier the *Journal of the Indian Mathematical Society* was started at Madras, India. The Calcutta Mathematical Society and the Spanish Mathematical Society have also started new periodicals during the last two or three years.

While there has been a very rapid spread of mathematical activity during recent years, it must be admitted that the greater part of the work which is being done in the new centers is quite elementary from the standpoint of research. The city of Paris continues to hold its preeminent mathematical position among the cities of the world; and Germany, France and Italy continue to lead all other countries in regard to the quality and the quantity of research in pure mathematics.

Although America is not yet doing her share of mathematical research of a high order, we have undoubtedly reached a position of respectability along this line, and it should be easier to make further progress. Moreover, our material facilities are increasing relatively more rapidly than those of the countries which are ahead of us, and hence many of our younger men start under very favorable conditions. Unfortunately, there is not yet among us a sufficiently high appreciation of scholarly attainments and scientific distinction. The honest and outspoken investigator is not always encouraged as he ought to be and the best positions do not always seek the best man. I coupled outspoken with investigator advisedly, since research of high order implies liberty and scorns shams, especially shams relating to scholarship. Even along these lines there seems to be encouraging progress, and this progress may reasonably

be expected to increase with the passing of those who belong to the past in spirit and attainments. What appears to be a very serious element in our situation is the fact that the American university professor does not yet seek and safeguard his freedom with the zeal of his European colleague. It is too commonly assumed that loyalty implies lying.

The investigators in pure mathematics form a small army of about two thousand men and a few women.¹² The question naturally arises what is this little army trying to accomplish. A direct answer is that they are trying to find and to construct paths and roads of thought, which connect with or belong to a network of thought roads commonly known as mathematics. Some are engaged in constructing trails through what appears an almost impassable region while others are widening and smoothing roads which have been traveled for centuries. There are others who are engaged in driving piles in the hope of securing a solid foundation through regions where quicksand and mire have combined to obstruct progress.

A characteristic property of mathematics is that by means of certain postulates its

¹² Between five and ten per cent. of the members of the American Mathematical Society are women, but the per cent. of women in the leading foreign mathematical societies is much smaller. Less than one per cent. of the members of the national mathematical societies of France, Germany and Spain are women, according to recent lists of members. The per cent. of important mathematical contributions by women does not appear to be larger, as a rule, than that of their representation in the leading societies. The list of about three hundred collaborators on the great new German and French mathematical encyclopedias does not seem to include any woman. Possibly women do not prize sufficiently intellectual freedom to become good mathematical investigators. Some of them exhibit excellent ability as mathematical students.

thought roads have been proved to be safe and they always lead to some prominent objective points. Hence they primarily serve to economize thought. The number of objects of mathematical thought is infinite, and these roads enable a finite mind to secure an intellectual penetration into some parts of this infinitude of objects. It should also be observed that mathematics consists of a *connected* network of thought roads, and mathematical progress means that other such connected or connecting roads are being established, which either lead to new objective points of interest or exhibit new connections between known roads.

The network of thought roads called mathematics furnishes a very interesting chapter in the intellectual history of the world, and in recent years an increasing number of investigators have entered the field of mathematical history. The results are very encouraging. In fact, there are very few other parts of mathematics where the progress during the last twenty years has been as great as in this history. This progress is partly reflected by special courses in this subject in the leading universities of the world. While the earliest such course seems to have been given only about forty years ago, a considerable number of universities are now offering regular courses in this subject, and these courses have the great advantage that they establish another point of helpful contact between mathematics and other fields.

Mathematical thought roads may be distinguished by the facts that by means of certain assumptions they have been *proved* to lead safely to certain objective points of interest, and each of them connects, at least in one point, with a network of other such roads which were called mathematics, *μαθηματικά* by the ancient Greeks. The mathematical investigator of the present day is

pushing these thought roads into domains which were totally unknown to the older mathematicians. Whether it will ever be possible to penetrate all scientific knowledge in this way and thus to unify all the advanced scientific subjects of study under the general term of mathematics, as was the case with the ancient Greeks,¹³ is a question of deep interest.

The scientific world has devoted much attention to the collection and the classification of facts relative to material things, and has secured already an immensely valuable store of such knowledge. As the number of these facts increases, stronger and stronger means of intellectual penetration are needed. In many cases mathematics has already provided such means in a large measure; and, judging from the past, one may reasonably expect that the demand for such means will continue to increase as long as scientific knowledge continues to grow. On the other hand, the domain of logic has been widely extended through the work of Russell, Poincaré and others; and Russell's conclusion that any false proposition implies all other propositions whether true or false is of great general interest.

During the last two or three centuries there has been a most remarkable increase in facilities for publication. Not only have academies and societies started journals for the use of their members, but numerous journals inviting suitable contributions from the public have arisen. The oldest of the latter type is the *Journal des Sçavans*, which was started at Paris in 1665, while the *Transactions of the Royal Society of London*, started in the same year, should probably be regarded as the oldest of the former type. These journals have done an

¹³ The term mathematics was first used with its present restricted meaning by the Peripatetic School. Cantor, "Vorlesungen über Geschichte der Mathematik," Vol. I. (1907), p. 216.

inestimable amount of good for the growth of knowledge and the spread of the spirit of investigation. At the present time more than 2,000 articles which are supposed to be contributions to knowledge in pure mathematics appear annually in such periodicals. In addition to these there is a growing annual list of books.

The great extent of the fields of mathematics and the rapid growth of this literature have made it very desirable to secure means of judging more easily the relative merit of various publications. Along this line our facilities are still very meager and many serious difficulties present themselves. In America we have the book reviews and the indirect means provided by the meetings of various societies and by such publications as the "American Men of Science."

The most important aid to judge contemporaneous work is furnished by a German publication known as the *Jahrbuch über die Fortschritte der Mathematik*. In this work there appear annually about 1,000 pages of reviews of books and articles published two or three years earlier. These reviews are prepared by about 60 different mathematicians who are supposed to be well prepared to pass judgment on the particular books and articles which they undertake to review. While these reviews are of very unequal merit, they are rendering a service of the greatest value.

The main object of such reviews is to enable the true student to learn easily what progress others are making, especially in his own field and in those closely related thereto. They serve, however, another very laudable purpose in the case that they are reliable. We have the pretender and the unscrupulous always with us, and it is almost as important to limit their field of operation as to encourage the true investigator. "Companions in zealous research"

should be fearless in the pursuit of truth and in the disclosure of falsehood, since these qualities are essential to the atmosphere which is favorable to research.

While the mathematical investigator is generally so engrossed by the immediate objects in view that he seldom finds time to think of his services to humanity as a whole, yet such thoughts naturally come to him more or less frequently, especially since his direct objects of research seldom are well suited for subjects of general conversation. If these thoughts do come to him they should bring with them great inspiration. Who can estimate the amount of good mathematics has done and is doing now? If all knowledge of mathematics could suddenly be taken away from us there would be a state of chaos, and if all those things whose development depended upon mathematical principles could be removed, our lives and thoughts would be pauperized immeasurably. This removal would sweep away not only our modern houses and bridges, our commerce and landmarks, but also most of our concepts of the physical universe.

Some may be tempted to say that the useful parts of mathematics are very elementary and have little contact with modern research. In answer we may observe that it is very questionable whether the ratio of the developed mathematics to that which is finding direct application to things which relate to material advantages is greater now than it was at the time of the ancient Greeks. The last two centuries have witnessed a wonderful advance in the pure mathematics which is commonly used.¹⁴ While the advance in the extent

¹⁴ In 1726, arithmetic and geometry were studied during the senior year in Harvard College. Natural philosophy and physics were still taught before arithmetic and geometry. Cajori, "The Teaching and History of Mathematics in the United States," 1890, p. 22.

of the developed fields has also been rapid, it has probably not been relatively more rapid. Hence the mathematical investigator of to-day can pursue his work with the greatest confidence as regards his services to the general uplift both in thought and in material betterment of the human race. All of his real advances may reasonably be expected to be enduring elements of a structure whose permanence is even more assured than that of granite pillars.

G. A. MILLER

UNIVERSITY OF ILLINOIS

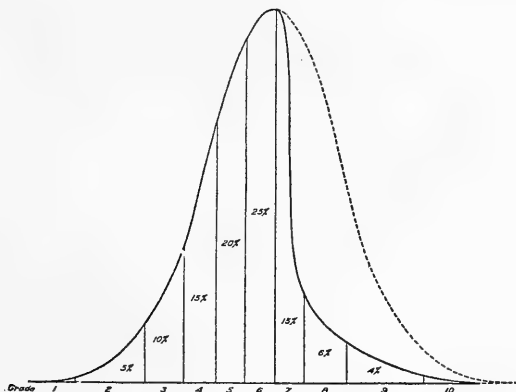
SCIENTIFIC DISTRIBUTION OF GRADES AT REED COLLEGE

A SCIENTIFIC rather than a personal basis for awarding grades in courses of study, if grades are to be used at all, together with definite credit for quality as well as for quan-

tute one vague expression for another. Without scientific definition, any set of symbols is inevitably used in personal, variable, erratic ways. To award scholarships, degrees and other honors, as if an *A* in one course represented the same distinction as an *A* in another course is to administer the curriculum on a patently false assumption.¹

Until all school work can be measured by scales, made up of units that are equal in a defined sense, the best available grading is one of relative position in a series. The nearest approach to such a scientific basis for awarding college credits appears to be a distribution following the normal probability curve, skewed to take account of the effect of selecting the student body.

The Reed College system is shown in the illustration. The outer curve, partly dotted, is the normal probability curve. The inner curve, partly coinciding with the other, shows



tity of work, seems desirable, especially for institutions that are more than theoretically devoted to scholarship, and that are willing to make what sacrifices such ideals may involve.

The common grades *A* to *E* have no defined meaning. To call them such and such a percent. of an undefined something is to substi-

¹It is impossible, here, to give a detailed explanation of the "credit for quality" system and the scientific distribution of grades adopted by Reed College. The underlying principles of both are fully explained in chapters 12 and 13 of the "Administration of the College Curriculum," Houghton Mifflin Company, 1911. "The Distribution of Grades on a Scientific Basis" is presented in *Popular Science Monthly* for April, 1911.

the result of selecting the student body, and would be vertical at the right side if it were possible to perfect the selection so as to exclude all below a certain standard and admit all above that standard.

Reed College uses ten grades. Ten, rather than any other number, are used, because tests by approved statistical and psychological methods show that fewer grades are inadequate to designate readily discernible differences, and many more grades can not be used with intelligent discrimination. The definitions of these grades have a scientific basis. Grades 1-5 indicate that a student stands in the upper half of an average class; grades 6-10 indicate that he is in the lower half. For example, 2 designates the work which will be done (in the long run) by the best 5 per cent. of all students, and 6 the work done by that quarter of an average class standing just below the middle. These particular percentages were chosen somewhat arbitrarily for the sake of convenient round numbers, but they correspond fairly well to the distribution shown in the probability curve as skewed from normal by the selection of students.

Grade 1 is rarely given, representing a degree of excellence attainable by not more than one student in four or five hundred; similarly, grade 10 records correspondingly bad failures. The lowest grade called passable is 8, which covers all cases where credit is granted conditionally or upon the satisfaction of some special requirement; 9 is for ordinary cases of failure.

It will be observed that the symbol 1 of the Reed College scale is a grade of real distinction, as the *A* of the usual scale is not; and that even the 3 of the Reed College scale represents quite as much distinction as the *A* if the latter grade were obtained by 15 per cent. of a class.

The grades, however, can not be interpreted in qualitative terms, as good, poor, *A*, *C*, 90 per cent.; nor do they designate rank in the particular class. They show the group in which the student would appear if the classes of several years were subdivided as indicated above.

Such a definition will not make a "2" = "2" as regards the actual quality of work done by the student, since this is a matter not only of the student's relative standing in the subject, but also of the actual standards set for that subject. But despite this, for courses of the same general sort (as introductory courses without prerequisites, whether coming in freshman or senior year), the relative rank in an average class seems to be the best available criterion of the student's merits.

In adopting the Reed College System, we attempted to divide the base line of the normal probability curve into equal parts; but we found this awkward, as grade 2 would then fall to but $1\frac{1}{2}$ per cent. of the students. We then tried (each side of the median) a distribution of 20 per cent., 15 per cent., 10 per cent., 5 per cent., which corresponds to equal bases for grades 4, 5, 6, 7 with somewhat longer bases for 3 and 8, and much longer ones for 2 and 9. This distribution seemed more convenient. We changed the distribution on the lower side, however, to 25 per cent., 15 per cent., 6 per cent., 4 per cent., to allow for skewing of the curve due to the influence of selection. What sort of divisions of the base line this requires no one can say without knowing the exact shape of the skewed curve (which depends on how effective the selective cut is), and knowing also how far the new median has been moved above the median in the normal curve (which depends on what area was cut off, according to the standard of selection). In using unequal divisions of the base line, therefore, we make a choice of percentages which is somewhat arbitrary, except that it follows roughly the sort of distribution in the skewed curve with equal base divisions.

With such a basis for grading students in their college courses, it is possible to give a definite and just reward for high scholarship by allowing a course completed with high credit to count more toward a degree than a course completed with lower credit. Such a plan for counting quality has the great advantage of enabling the students who do the best work to graduate in less than the normal

time, without tempting them to take more subjects in a given year than they can creditably pursue.

WILLIAM T. FOSTER

SCIENTIFIC NOTES AND NEWS

By the untimely death of Wilbur Wright the country loses an inventor of distinction, whose great achievement in the development of the aeroplane gives him high rank among those who have contributed to the practical applications of science.

DR. WILLIAM McMICHAEL WOODWORTH, of the Harvard Museum of Comparative Zoology and the author of important contributions to zoology, has died at the age of forty-eight years.

VICE-PRESIDENT THOMAS JONATHAN BURRILL and Comptroller Samuel Walker Shattuck, of the University of Illinois, will retire from active service at the end of the present academic year, having been granted special retiring allowances by the Carnegie Foundation for the Advancement of Teaching. Both of them have been with the university since its foundation in 1868, and have been potent factors in its upbuilding. Dr. Burrill has served as professor, dean, vice-president and acting president and has done notable research work in botany and bacteriology. Professor Shattuck has served as professor of mathematics, vice-president and comptroller.

DR. HENRY T. EDDY, head of the department of mathematics and mechanics at the University of Minnesota and dean of the graduate school, will retire from active service under the terms of the Carnegie Foundation.

PROFESSOR THEODORE W. RICHARDS, of the department of chemistry of Harvard University, lectured at the University of Michigan upon "Atomic Compressibility" on May 16. On May 17 he was awarded the Willard Gibbs medal by the Chicago Section of the American Chemical Society, and delivered an address upon "Atomic Weights."

THE death of Lord Lister having created a vacancy in the membership of the Royal Society of Science, Upsala, Sir Victor Horsley, F.R.S., has been elected his successor.

THE Société Astronomique de France has, says *The Observatory*, lately taken advantage of two anniversaries to pay honor to the founder and past-president of the society. January 28 last was the twenty-fifth anniversary of the founding of the society, and this year is the fiftieth of M. Flammarion's career as an astronomical writer, for his first great work, "La Pluralité des Mondes habités," was published in 1862. The actual ceremony took place in the large hall of the Sociétés Savantes on the evening of February 26, which happened to be M. Flammarion's seventieth birthday, so that three anniversaries were celebrated.

As a memorial of Professor Ralph S. Tarr a volume is to be published consisting of essays on physiographic and geographic subjects, the work of men trained by him. A committee has been named to take charge of the preparation and publication of the volume. This committee has asked Dr. Frank Carney, professor of geology in Denison University, to edit the work.

THE completion by Rudolf von Jaksch of twenty-five years as professor of internal medicine at Prague was celebrated recently. The *Prager med. Wochenschrift* issued a special number in his honor and a *Festschrift* was presented to him.

COLONEL SIR DAVID BRUCE, C.B., F.R.S., has been promoted to the rank of surgeon general in the British Army, in consideration of his eminent services to the cause of science. Sir David Bruce is at present at the head of the Sleeping Sickness Commission appointed by the government, with the advice of the Royal Society, to continue the study of the disease in Nyasaland.

A GRANT of \$140 from the C. M. Warren Fund of the American Academy of Arts and Sciences has been made to Professor Arthur B. Lamb for work upon the rhodiumamines.

HARRY MILES JOHNSON, Ph.D. (Hopkins '12), has been appointed psychological assistant in the physical laboratory of the National Electric Lamp Association, Cleveland, Ohio.

THE American Road Builders' Association gave a dinner at the Hotel Astor, New York

City, on June 5, in honor of W. Rees Jeffreys, Esq., secretary of the road board of England and honorary general secretary of the local organizing committee of the third International Road Congress to be held in London in June, 1913.

PROFESSOR THOMAS A. JAGGAR, JR., professor of geology in the Massachusetts Institute of Technology, has been granted leave of absence for five years, and sails for Honolulu early this month to take charge of the Volcano Laboratory of the institute on the crater of Kilauea. Drs. A. L. Day and E. S. Shepherd, of the Carnegie Institution, are now in Hawaii and expect to spend the summer in investigations of optical pyrometry and spectroscopic analysis.

PROFESSOR ELLSWORTH HUNTINGTON, of Yale University, will this year carry further the work of investigating climatic changes during the last two or three thousand years which he undertook last summer under the auspices of the Carnegie Institute of Washington. Accompanied by Professor H. S. Canby, he has left for California, where he will be joined by a party of four or five students and others from the University of California. They will proceed into the Sierra Nevada Mountains in the King's River section south of Yosemite, where they will spend two months measuring trees.

PROFESSOR ALFRED DODGE COLE, head of the department of physics at Ohio State University, has been granted leave of absence for the college year 1912-13. It is probable that he will spend four months in research at the National Bureau of Standards, Washington, and a semester similarly at the University of Berlin.

DR. ALBERT BUSHNELL HART, professor of the science of government at Harvard University, is at present lecturing at Colorado College in Colorado Springs as exchange professor. He is giving lectures on American history (1850-1865), on American biography, and on the Orient (Japan, China, Philippines, India).

The Harrington lectures arranged by the medical faculty of the University of Buffalo

will be delivered in Alumni Hall by Dr. Ludwig Hektoen, of Chicago, on May 28 to 31, on "Immunity."

PROFESSOR C. A. ADAMS, of Harvard University, gave a lecture "On the Place of the Engineer in Modern Society," at the University of Vermont on the evening of May 15, and a lecture on "The Synchronous Motor," on the morning of May 16.

The Illinois State Association of Operating Engineers met at the University of Illinois on May 24. Addresses were given by President James, Dean W. F. Goss, of the College of Engineering, Professor Parr and Professor Bartow, of the department of chemistry.

A CONFERENCE will be held at the Graduate School of Agriculture, Lansing, Mich., on July 24, to discuss the formulation of standard rations for experimental work in determining the comparative value of feed stuffs. Mr. B. H. Rawl, chief of the dairy division, U. S. Department of Agriculture, President H. J. Waters, of the Kansas Agricultural College, Professor C. H. Eckles, of the Missouri Experiment Station, and other leading workers in this field are expected to be present and lead the discussion.

ALL persons interested in the scientific section of the American Pharmaceutical Association are requested to notify any of the officers of the section of the title or titles of the paper or papers that they contemplate presenting before the section at the annual meeting of the Association at Denver, Colorado, August 19-24 inclusive, 1912. Original papers of scientific interest, whether directly of pharmaceutical interest or not will be considered by the committee. The committee on scientific papers consists of W. O. Richtmann, *chairman*; F. P. Stroup, *secretary*, 145 North 10th St., Philadelphia, Pa.; F. R. Eldred, associate, 3323 Kenwood Ave., Indianapolis, Ind.

THE second annual meeting of the American Climatological Association will be held in Hartford, Conn., June 10-12, under the presidency of Dr. A. D. Blackader, Montreal.

The conference of bath officials and others interested in public baths, held at New York City, on May 14 and 15, resulted in the or-

ganization of the American Association for Promoting Hygiene and Public Baths. Dr. Simon Branch, professor in the medical department of Columbia University, who has for nearly twenty years led the movement for free public baths, was elected president, and Dr. William H. Hale, permanent secretary. The annual meeting will be held on the second Tuesday of May, the next meeting being at Baltimore, May 13, 1913. The membership fee is one dollar a year and all persons of good character are eligible for membership.

A CABLEGRAM received at the Harvard College Observatory from Kiel states that a spectrogram of Enebos Nova obtained by Kuestner at Bonn shows "dark lines uranium radium emanation."

WE learn from the London *Times* that Messrs. Sotheby sold, on May 17, the scientific books of the late Sir Joseph Dalton Hooker, among which were several presentation copies, whilst many were with valuable MS. notes by the late owner. A set of Hooker's *Icones Plantarum*, 1837-1911, 30 volumes—£37 (Wesley); Edwards's *Botanical Register*, 1815-47, 33 volumes—£26 (Muller); and a collection of books on the "Flora" of the Antarctic regions, New Zealand, etc., in nine volumes—£123 (Wesley). The late Dr. Joseph F. Payne's property included a slightly defective copy of Apuleius Platonius, "Herbarium," Rome, 1488, the earliest printed book with figures of plants—£55 (Leighton); J. Milton, "Areopagitica," 1644, the very rare first edition, one page slightly cut into—£21 (Barnard); and Joannem de Cuba, "Tractatus de Herbis," etc., 1491, with numerous woodcuts of plants and animals, slightly defective—£35 (Quaritch). The two days' sale of books realized £1,488 14s.

ACCORDING to the *Journal* of the American Medical Association the births for 1910 were 35,119 and for 1911, 69,098 below the average for the decade 1901 to 1910, while the number of marriages in the first year was 10,154 and in the latter 20,897 above the average in that period. It is therefore evident that the fertility of married women has shown a considerable decrease. For each 1,000 of the pop-

ulation there occurred in 1911 30.2 births as compared with 31.5 in 1910, 32.7 in 1909, 33.7 in 1908 and 37.4 in 1901, so that in ten years the birth rate has dropped by 7.2 per thousand. The number of deaths in 1911 was 18.1 per thousand, as contrasted with 16.9, 17.9, 18.9 and 21.7 in the four preceding years. According to these figures, the excess of births for 1911 was 12.1, as compared with 14.6 in 1910, 14.8 in 1909 and 1908 and 15.7 in 1901.

UNIVERSITY AND EDUCATIONAL NEWS

NEARLY \$1,000,000 was appropriated by the General Education Board at its meeting on May 24. \$250,000 is given to the George Peabody College for Teachers at Nashville, Tenn., for the establishment of the Seaman A. Knapp School of Country Life. The other colleges awarded conditional appropriations are: Beloit College, Beloit, Wis., \$100,000; Coe College, Cedar Rapids, La., \$100,000; McAlester College, St. Paul, Minn., \$50,000; University of Rochester, Rochester, N. Y., \$200,000. The sum of \$210,000 was set aside for demonstration work in agriculture in the southern states, for professors of secondary education in state universities of the south, and to aid the work of Negro education in the south.

PROFESSOR OTIS F. RANDALL, who holds the chair of mechanics and mechanical drawing at Brown University, has been appointed dean of the university to succeed Professor Alexander Meiklejohn, who is to become president of Amherst College.

DR. GEORGE DOCK has resigned the deanship of the medical department of Washington University, St. Louis. Dr. Dock will continue as professor of medicine.

DR. DAVID RIESMAN and Dr. Joseph Sailer have been elected professors of clinical medicine in the medical department of the University of Pennsylvania, in succession to the late Dr. John H. Musser. Dr. Richard M. Pearce occupies the John Herr Musser professorship of medical research.

VICTOR C. MYERS, Ph.D. (Yale, '09), has been appointed professor of pathological chemistry, and has taken charge of the new labora-

tory for pathological chemistry recently opened at the New York Post-Graduate Medical School and Hospital.

PROFESSOR WILLIAM E. BROOKE, of the College of Engineering, University of Minnesota, has been appointed to fill the vacancy caused by the retirement of Dr. H. T. Eddy, the head of the department of mathematics and mechanics. Dr. William F. Holman takes the place made vacant by the retirement of Dr. Arthur E. Haynes, from the department of mathematics.

THROOP POLYTECHNIC INSTITUTE, of Pasadena, California, is materially enlarging its department of chemistry with a view to keeping in touch with the industrial development of southern California, especially in connection with the oil industry. Dr. Richard Sidney Curtiss, Ph.B. (Yale, '88), Ph.D. (Würzburg, '92), now professor of organic chemistry at the University of Illinois, has been appointed professor of organic chemistry and research associate. Charles Andrew Brautlecht, Ph.B. (Yale, '06), now doing graduate work at Yale, has been appointed instructor in chemistry and physics. William Ruthven Flint, A.B. (Yale, '98), Ph.D. (Yale, '09), continues in the department as professor of inorganic and analytical chemistry.

OWING to the rapidly growing interest in the science of chemistry and the recognition of its importance in the development of the state resources, the president and regents of the University of California have provided for the enlargement and reorganization of the department of chemistry. In addition to the present staff, the following appointments have been made: Professor Gilbert N. Lewis, of the Massachusetts Institute of Technology, professor of chemistry and chairman of the department; Professor William C. Bray, of the same institution, and Professor Richard C. Tolman, of the University of Cincinnati, assistant professors of chemistry. Several additional instructorships and assistantships have also been created. Owing to the absence of Professor Morgan, the course in elementary chemistry will be in charge of Professor Harry W. Morse, who has received for this purpose

leave of absence for one year from Harvard University. Professor Edmond O'Neill has been appointed director of the chemical laboratory. Owing to the crowded condition of the present laboratory, a new building on the site provided in the Hearst plans will soon be begun. In the mean time, a temporary building is being constructed, and will contain a laboratory of physical chemistry, several offices and research laboratories and shops for mechanician and glass blower. Much attention will be given to the development of advanced study and research. A considerable number of men, several of whom come from other institutions, will enter next term as candidates for the doctorate. Advanced seminars will be offered in organic, inorganic and physical chemistry.

DISCUSSION AND CORRESPONDENCE

THE HEATING IN THE CULEBRA CUT

TO THE EDITOR OF SCIENCE: Mr. MacDonald's interesting article on the heatings in Culebra Cut, in your issue of May 3, No. 905, is paralleled by the spontaneous combustion of bituminous coals, and even of the anthracite culm banks, owing to the oxidization of pyrite. It is a common occurrence, and is the cause of endless trouble in preserving museum specimens of pyrite in fine dissemination during damp weather.

In the case at issue the iron content proceeded from the ferro-magnesian silicates, as Mr. MacDonald has stated; but from ordinary surface oxidation, as is always the case in regions containing the black bisilicates, and as shown by the rustiness of springs and streams. The sulphur content is also generally present in lagoons as more or less dilute sulphuric acid. The presence of carbonaceous material points to a lagoon formation at Culebra Cut.

The function of iron is to be a carrier of oxygen from the air to the precipitated organic debris, changing from hydrated sesquioxide to protoxide: picked up by the above acid: again breaking up as hydrated sesquioxide, and continuing its endless rounds unless it happens to be included and imprisoned under a mass

of vegetation; when the round is stopped, the sesquioxide and the solution of sulphate in which all the ingredients are bathed are robbed of the oxygen and form pyrite.

The classic laboratory experiments show that organic animal matter acts with greater rapidity and sureness, and the resulting pseudomorphs of sphalerite, chalcopyrite, or pyrite, when a live clam is placed in a saturated solution of a sulphate of the above, are well known. We find them abundantly in nature, in the Trenton rocks as well as in the coal measures.

EDWARD H. WILLIAMS, JR.

THE CROCKER LAND EXPEDITION

TO THE EDITOR OF SCIENCE: The Crocker Land Expedition which was to have gone northward this summer under the leadership of George Borup and D. B. MacMillan, has been postponed to the summer of 1913, on account of the lamentable death of George Borup and the impracticability of finding a substitute for him in the short time remaining before the expedition was to start.

The Honorary Committee, consisting of President Henry Fairfield Osborn, Mr. Chandler Robbins, General Thomas H. Hubbard and Dr. Walter B. James, and the Committee in Charge, comprised of Dr. E. O. Hovey and Mr. H. L. Bridgman, have begun the reorganization of the expedition along such lines as circumstances may necessitate, without changing the main objects of the enterprise, as set forth in the prospectus issued in January 1912.

Colonel Borup and a number of the principal supporters of the expedition have united in the furtherance of the new plans; the expedition will be a memorial to George Borup, the young explorer who was so keenly interested in it and who was the mainspring of the original undertaking.

Mr. MacMillan's connection with the enterprise continues as heretofore, and he is utilizing the intervening time for the purpose of making additional preparation for the scientific work of the expedition.

A considerable part of the supplies and equipment had been prepared. The prepared

material has been put into safe storage for use next year, while the special apparatus is being assembled at the museum. Subscriptions already made are sufficient to insure the starting of the expedition a year hence.

EDMUND OTIS HOVEY,
HERBERT L. BRIDGMAN,
Committee in Charge

UNIVERSITY CONTROL

LETTERS FROM HARVARD UNIVERSITY

I AM on the whole very pleasantly impressed, as you know, with the general constitution that has been worked out at Harvard: a bi-cameral arrangement for the general governing boards; one large academic faculty and several professional faculties for the boards of instruction; comparatively independent divisions and departments, with a considerable range of initiative within their own fields; a president who is, while powerful, still subject to a great many decidedly distinct and potent sorts of checks from alumni and from various boards. This constitution does not seem to me perfect. The president at Harvard has probably still too large a range of discretion. The result is certainly not bad; but is also still subject to further growth. The bi-cameral system (the "overseers" elected by the alumni, able to advise but not to initiate legislation, able also to veto; the "corporation," self-perpetuating and capable of initiating, but always subject to the overseers' veto), seems to me to work well but unevenly, since the overseers have their seasons of too great or too little activity, while the president is probably a little too potent in influencing the corporation legislatively. Nevertheless, I regard the result of the interaction between the "overseers" and the "corporation" as so useful in many crises, and so convenient both in calling out and in holding in check the interests of the alumni, that I can not be convinced of the value of your proposals 1 and 2, if they were regarded as contemplating a constitution intended to take the place of ours. I should say, in place of your proposal (1), that a bi-cameral governing body like ours is preferable to the

arrangement that you prefer. Let the alumni, or in state universities, perhaps some larger constituency of interested persons, elect one governing board—not one of absolute authority, but a representative and influential board, with a veto power large enough to be a significant guard, and an advisory power large enough to keep the university in touch with its public. Let there be another board, of another origin, to act as legal owner of the property. Let this board have a real, but not too potent authority as a manager of affairs. Let these two boards cooperate with mutual criticism. Then you could afford to give your president more power and dignity than you do in number (2). I do not agree that the president should be as shorn of power as you make him. Let him be reasonably limited, but not helpless. "Security, permanence, honor" are all consistent with a reasonable presidential leadership. With the spirit of your proposals (3) and (4) I am, on the whole, in sympathy, although I could not go so far as you do. I am willing, as at Harvard, to submit the appointment of officers of instruction to the veto of general governing boards; and to have those boards, as well as the faculties and other teaching "units," take part in all legislation that concerns general educational policies. A professor should have a solid tenure of office during good behavior, and should also have freedom of teaching. A department, or division, or other such small "unit" should have a large scope of discretion as to its own work. But one must keep in touch with one's alumni and one's public as to all questions of common educational policy; and this is why the legislation by general boards is needed, as well as the relative autonomy of departments and of individual teachers. You insist on the latter. To that insistence I agree; but I want the general boards to aid also in legislation. As to (5), I think that you go too far in expecting the departments or divisions to elect a senate capable of doing all their principal legislation for them. Once more—a frequent interaction with governing boards of the type of our Harvard "overseers"—boards that represent the

alumni, and that can veto rather than initiate, seem to me a useful aid and check. What one wants is to get all the forces expressed in the university life, without arbitrary mutual interference, but with constant and mutual criticism, and without anarchy, although with plentiful individual freedom. On the whole that is what we have at Harvard.

I recognize the danger of your "Scylla of presidential autocracy" and "Charybdis of faculty and trustee [collective] incompetence." But I have seen so much efficiency, of the right kind, result from the lodging of great powers in the hands of a wise and able president that I am unwilling to agree, concerning this officer, that "his salary should not be larger, his position more dignified or his powers greater than those of the professor." Of course the right man for president is hard to find, and of course the wrong man is occasionally chosen. I wish that every man accepting a university presidency might do so with assurance of the opportunity to retire at any time from the office on a respectable pension; this would be a happy way out, for the president and for the university, in many unfortunate cases; but I would not see the powers of a well chosen, well qualified president stinted. On the other hand, I have seen a great president content to lay his most cherished projects before a large faculty and labor year after year to bring this faculty to his own way of thinking, convinced that in this assembly he had, on the whole, the most intelligent and the most fairminded body of men in the world, for his purposes. The deliberative habits of this faculty under the president were most exasperating to those who are fond of swift decisions in educational questions, and by common consent, as matters of general interest pressed upon us, matters of detail and routine were delegated more and more to committees or to special administrative officers. Moreover, departments or divisions, as they grew in size, assumed new functions, somewhat as they should according to your plan. But through all these changes, a faculty remained a fairly coherent body, mem-

bers generally, old and young, feeling that, when certain questions of general policy were up, each man of them was expected to do his duty, though comparatively few, as a rule, took an active part in the debates. Furthermore, the frequent faculty meetings, though they did not by any means make every member know every other member, tended advantageously toward general acquaintance, and individuals who, from temperament or from departmental affiliations, must differ, could at least differ more intelligently than if they had not known each other by sight. The combination which I have described, a masterful but considerate president, strong enough and fair enough to invite frank counsel, with a faculty willing to give this counsel in a broad spirit of loyalty, has existed, I believe, not in one institution alone, but in many. With this combination formal checks and balances of authority are needless; without it they are of little avail. It seems to me the "necessary and sufficient" condition of genuine success for a university dealing with educational problems as they exist in this country. In using the term faculty I mean a body which controls the instruction leading to some degree or degrees, and I am not advocating general meetings of all the various faculties which may exist together under the university name. It is unlikely that any president could feel himself equally a master of the situation in all the various faculties, arts, law, medicine, etc., of a modern full-fledged university; but the advantage of having some one active man to preside at all meetings of these faculties, to watch, and report upon, and in a measure control, the relations of the several faculties to each other, seems great. A "chancellor" for show occasions, "to represent the university at public functions" or even "to obtain endowments," would, I think, be ineffective in comparison. As to the selection of professors, I fear that the plan of having all nominations come from departments might result in that condition of academic inbreeding which is noted in some places. At any rate, the faculty selection of professors appears to have had a tendency toward this condition in cer-

tain institutions. I am sorry to take issue with you on some of your most important propositions, for I agree with much that you maintain, and especially with your declaration that "security, permanence, honor, the slow growth of traditions, are essential to a true university." The proposition that great salaries are needed to induce able men to enter university positions, or that great salaries would bring into university professorships the best men, on the whole, for these places, I hold to be fallacious. Great salaries are not needed to call great lawyers from the gainful practise of the bar to the security and honor and sense of public service which they find on the bench. Every teacher, every "productive scholar," should feel himself to be a servant of the public, of a public wider, it may be, than any judge can serve. He should bear himself, and be honored, accordingly.

The plan which you outline is an interesting one which I should be glad to see tried as an experiment somewhere where I am not. The gravest danger I see in it is the proposition that professors be nominated by the departments. This would almost inevitably have the tendency to cause the promotion of men already in the departments, rather than the securing of the best man available, if he happened not to be there. The method of nomination by a faculty composed of only the full professors, as is the case in Germany, obviates this difficulty, since the full professors are no longer looking for advancement, and an appointment from outside will not put any one ahead of them as would be the case for all other members of the department. I am not at all sure that even this method of selection by a faculty of full professors is superior to the present methods commonly in vogue. Yale, I believe, has such a system, and I do not see that the appointments there have been unusually strong. The main reason why I feel doubt about your scheme is that the averages of our faculties the country over are still so low intellectually. Mediocrity is the almost unbroken rule. No doubt this will improve in time; it has improved greatly during

the last twenty years. At present, however, I feel that we have a better chance to secure men of intellectual alertness in the president's chair than as a composite photograph of a faculty or department. The catch-words of democracy and autocracy do not appeal to my judgment here. Of course I am with you in desiring to see the universities and colleges of the country so administered that the faculty members shall not feel that they are merely employees of the corporation (trustees), but that they have a large share in deciding policies and in the making of minor appointments. I do not believe it is necessary, to secure this end, to abolish practically as you propose the office of president. I doubt whether during the present generation at least a satisfactory substitute for the president can be devised.

The organization proposed under (1), (2), (3) and (5) depends for its success largely on the possibility of finding a man with the requisite qualifications for president, and securing his election. In throwing the responsibility for this choice directly on the faculty it would have a wholesome effect on this body. But whether any man with no more power given him than you propose for the president could become a leader is doubtful. Certainly Mr. Eliot could not have accomplished what he did for Harvard under this plan. But conditions have changed since then, and more could be done with the plan now. Still, are not our faculties too much bound up in the supposed interests of the undergraduate and with the cruder needs of this immature person, to be willing to take any chances when it is a question of higher scholarship? Are we ripe for this plan? I hope we are; but I do not know. The method of making appointments set forth in (4) is, I believe, a wrong one. At the present time there are not enough first-rate men in mathematics in the whole country to supply even the strongest universities, and I presume the situation is similar in other subjects. It is necessary, then, to discover the man who is scientifically strong early, and moreover it is neces-

sary to want to get the man who is scientifically strong. Now the majority of the men whose vote is necessary for a choice under your plan are not themselves scientifically first-rate men, nor do they know a first-rate man when they see him. They are going in any concrete case to impose conditions, each in itself corresponding to a desirable qualification, but all taken together such that the one (or possibly two) otherwise available first-rate men are ruled out. The result will be the choice of an eminently respectable member of society, who as he grows older will add so much more dead wood to the department and in his turn make the choice of a scientifically strong man difficult or impossible. If really strong appointments are to be made, the choice must rest ultimately with one or two men, as the president and the head of the department; and even two is sometimes too many. There have been cases at Harvard where Mr. Eliot has appointed professors from outside without the advice or consent of the departments, much to the good of the department in question. It is true that when both president and the head of a department are incompetent, good appointments are impossible. But only an act of God can save such a department.

I am inclined to think that the best form of government is beneficent tyranny, but of course such a person as Marcus Aurelius should always be chosen as tyrant. That there are some individuals more intelligent than the average, there can be no doubt. The point is to choose these as our leaders. Personally, the less I have to do with the details of running the university, the happier I am.

I have never reflected on the matter of college administration and my opinion is therefore of no value, and might readily be reversed by study, argument or reflection. I see no reason as yet for believing in your plan. A system like that of Harvard seems to me to work well.

Your plan of a representative rather than a town-meeting faculty seems to me excellent.

The rest of the plan seems to me no better than the one in use here, which has stood the test of use admirably.

I rather believe in finding the right man and then giving him a good deal of power. I confess the practical workings of democratic systems do not inspire me with confidence. In short, I believe in a centralized form of government for universities. This is more a matter of personal feeling than anything I can back with logic. I am quite ready to admit that such a system may not work well in a great many cases, though I think it is satisfactory here at Harvard. If the government of a university is to be of a democratic type then I have very little to criticize in your circular. I don't think a president and a chancellor would work very well. Why not have the trustees elect a president who would be commander-in-chief and then let there be a vice-president chosen by the senate to represent the academic side on the board of trustees? As to units, twenty seems to me too small a number. Why not have two or three faculties of fifty or more each? General discussion is a good thing. But these are minor points.

I can do no better than state my own experience in two universities, viz., Harvard and Toronto. First, I must say that I do not regard the university professor as such, as a progressive entity. He appears to me on the whole to be much less progressive than the average non-academic man. As a consequence of this feature of his psychology, it is often to the advantage of the institution, with which he happens to be connected and certainly to the advantage of his more progressive colleagues, if he has any, that he should feel the spur of presidential displeasure at times. When I was connected with the University of Toronto, there were many things which badly needed setting right, so much so that the university was investigated by three royal commissions within a decade. The remedy which was finally chosen was the appointment of an autocratic president of the American

type. So far as I am aware the academic machine has worked very well since this change. At Harvard the forces of conservatism, not to say the *vires inertiae*, are quite as strong as they are in any other university I have had experience of, and I happen to know that the academic lives of some of the members of the Harvard staff who may possibly be more progressive or energetic than their immediate colleagues, would scarcely be endurable, but for the fear of the omnipotent president. This is true not only of President Eliot's régime, but also of that of the present incumbent, President Lowell. It appears to me that, on the whole, autocratic powers on the part of a university president are a necessary evil. It does appear, however, that there should be some machinery which, in cases of extreme injustice, might exercise a veto on his acts. I do not think that a president having only a limited tenure would be valuable to the university, nor do I believe that it is very desirable to make his position less dignified than it is at present. A very great desideratum at the present time seems to be a professor's protective association, which among its functions might insure its members against unjust loss of position, and which might also act as the advocate of professorial rights in a general way. University professors at the present time in American universities are too much at the mercy of the administration.

I hardly feel qualified to express an opinion about general university organization that would be worth while. I will outline to you the organization that we have in the Harvard Medical School, because it seems to work satisfactorily under our conditions, and this may be of some help to you. (1) The Medical School has an independent budget made up of the income from funds given definitely to the Medical School, and of fees from students. The Medical School pays its proportionate share of the expenses of the general university, such as the president's salary, etc. (2) The Medical School has its own faculty, which is large, as is the custom with Harvard faculties. This faculty is presided over by the

university president, and bears the same relation to the corporation and to the board of overseers of the university as do other Harvard faculties. (3) All teachers appointed for more than one year are members of the medical faculty. These teachers are appointed by the corporation with the consent of the overseers on the recommendation of a committee composed of all full professors in the Medical School. (4) There is a dean of the faculty of medicine, a dean of the Medical School and a dean of the Dental School. The dean of the faculty of medicine is responsible for the preparation of the general business of the faculty. The dean of the schools is responsible for the individual school, its business and its budget. The deans are appointed by the corporation without vote on the part of the full professors. (5) The various departments in the Medical School are organized into six divisions, each division made up of closely allied subjects. Each division elects a chairman, and each member of the component departments who has been connected with the Medical School for more than one year is entitled to a vote. The six chairmen so elected, with the dean of the school, constitute a faculty council, and the faculty council has supervision of matters concerning the curriculum, the extension of the work of the Medical School, etc. To it are referred recommendations from all the divisions and departments for consideration and report to the faculty. In the same way matters brought up in the faculty touching these points are referred to the faculty council for consideration and report. (6) Assistants and instructors reappointed annually are nominated by the professors in the various departments, and their nomination referred to the division acting as a committee on these nominations. If approved by the division, these nominations are sent to the dean, and by him to the corporation for appointment. (7) There is an administrative board of the school appointed by the corporation, which with the dean act upon matters affecting student discipline, to a certain extent financial matters, that is, discussions of appropriations and awards of

scholarships, etc. This seems a rather cumbersome organization, and is probably in part the result of the accretions of time. However, under it pretty nearly every one connected with the Medical School has an opportunity in one place or another to freely express his views on matters concerning the policy of the Medical School, and in some way to record them by vote. At the same time those holding more responsible positions are given an opportunity to have a proportionately larger influence on Medical School matters.

So far as the general outline of your plan is concerned, I should express approval. It may interest you if I tell you something of what we have done here in the Medical School within the last two years as the result of an agitation initiated about seven years ago. Two years ago the present organization was adopted, and it works exceedingly well. The departments of the school—the department means all those which give a separate examination, or which have an assistant or full professor at its head—were organized in divisions of allied subjects. There were six such divisions, lettered A, B, C, D, E and F. Division A includes the departments of anatomy, comparative anatomy and the Warren Museum. Division B includes physiology, comparative physiology, biological chemistry, materia medica and therapeutics. Division C includes pathology, comparative pathology, bacteriology, preventive medicine and hygiene, neuropathology. Division D includes theory and practise, clinical medicine and surgery, psychiatry, pediatrics. Division E includes surgery, orthopedic surgery, obstetrics, gynecology. Division F, dermatology, syphilis, ophthalmology, otology, laryngology. Each division consists of all members of the constituent departments. Those entitled to a vote in the division are members of the faculty, instructors and assistants who have served three years or more. Each division elects its own chairman and a secretary, and matters of interest to any member of the division are brought up for discussion at meetings held for the purpose. The chairmen are

elected for terms of three years, and are not eligible for immediate reelection. The president of the university, the chairmen of the divisions and the dean of the school make up what is called the faculty council. This council considers all questions arising in regard to courses of study or extension of medical study, the general development of the medical school and the creation of new departments, and reports on the same to the faculty of medicine. Questions on such topics may originate in a division and be brought before the council for consideration, or they may originate in the council; but in such case, no matter directly concerning a division or a department shall be referred to the faculty for action until it has previously been referred to a division for discussion and recommendation to the council. Of course there are other details, but I will not make this letter too long by putting them before you. The general plan has now been working for more than two years, and seems to be meeting with entire approbation. Certainly the results are good in that they have brought together men and interests that before were drifting widely apart. It may interest you to know that this scheme is being discussed with a view to its adoption in at least two large medical schools. The essential point in which it differs from the organization of, say, the Johns Hopkins Medical School, is that it increases the dignity of the professor and does not compel a young man who has secured such rank to remain under the control and tutelage of an older professor or else change his university. The fundamental objection to the Carnegie report on medical education has always seemed to me to be the assumption that the Johns Hopkins organization is the best. In the case of that university it undoubtedly worked well, because they were fortunate in securing strong men in the beginning; but certainly the present indications are that they must either reorganize and give some of their juniors independence or else lose them.

It seems to me that the general plan outlined is excellent in so far as it gives a hand

in the control of a university to those who are most intimately interested in its welfare; namely, its alumni, its faculty and the section of the community at large which it serves. I think it is also excellent, in so far as it seeks to increase the dignity and respect in which a university chair should be held by all persons. The weakest part of the scheme, as it seems to me, lies in the direction for securing new professorial appointments. It goes without saying that each department of a university contains among its teachers expert judges of the intellectual standing of men outside the university, prominent in various lines of scholarship and achievement. In so far as the faculty members are judges of the standing of outside men, their judgments are of great value, when the question of appointing a new man to an assistant professorship or a full professorship comes uppermost. On the other hand, I think that a faculty may often err in its judgments as to the type of intellectual work that should be encouraged in a university. I think that in some cases experience has shown that faculties invested with the power of appointing new professors, subject to the approval of trustees, have erred grievously in policy, by appointing men too narrowly along certain intellectual lines. For example, I can readily imagine that at some particular university, some particular subject may be taught by the faculty members in its department, who may be staunch supporters of some particular doctrine or line of work. The men in that department are naturally and properly enthusiastic and earnest in their desire to see their favorite line of intellectual work extended. If they are empowered to appoint new faculty members, they are likely, with the best and worthiest of motives, to appoint new men whose views and work lie parallel to their own. The consequence of continuing such elective policy, might, in the course of years, unbalance a university seriously, developing its activities too extensively in some particular lines, to the neglect of other lines equally important. For the above reasons I consider that while the faculty of a university should have some hand in appoint-

ing new members, the president or some equivalent power should be able to prevent the university becoming too one-sided. It should lie in the hands of the president, or equivalent power, to introduce such new men into the faculty as may permit of the university work expanding harmoniously and uniformly. Of course, the appointing power in the hands of a president tends to give large influence to an individual. To counterbalance that tendency, along the lines of your plan, it seems to me that it should lie out of the power of the president to dismiss faculty members except for flagrant cause. Faculty resignations should only be exacted by faculty action. To sum up, I should like to see your scheme amended by giving appointing power, under certain restrictions, to college presidents, but giving dismissing power exclusively to faculties.

The plan you propose has many advantages. In the case of a department devoted to research it is very important that the officers concerned, who are familiar with the subject, should have almost complete control of the administration, especially as regards the appointment of the staff and the plans of work. It is a misfortune when such a department is controlled by a body of men who have no technical knowledge of the work undertaken, or, by personal inspection, familiarity with the investigations actually in progress. It is particularly unfortunate when such a body is more interested in another department of the university and is likely to take action for the benefit of the latter at the expense of the former. The case is like that of the stockholders of a small railway controlled by a larger railway system. Their interests are likely to be sacrificed for the benefit of some portion of the system in which the directors have greater interests. As regards the details of your plan, I think that you go too far in reducing the powers of the president. Every university should have one man of very high grade who would devote his entire time to the work. He must be a man of affairs and capable of keeping the work of the university

before the influential portion of the public. I do not believe in the English system of a non-resident chancellor who is simply a figure-head. If the various departments were represented on the governing board, and had the right of nomination as proposed in your (4), the powers of the president would be sufficiently reduced. With these modifications your plan seems to me a good one.

(1) I do not see why members of the corporation should pay annual dues. It seems to me likely that the revenue would be smaller under this system than under the present one in which many men elected to university offices voluntarily give much time and money to worthy objects which they foster. I also think it advisable to keep in all forms of government some degree of subordination and that the best interests of all the professors of an institution are best guarded by having the allotment of funds in the hands of men who are unhampered by personal interest in obtaining an allotment as must be the case where a professor serves as a member of the corporation or body making allotments. The tendency would, I fear, be to work to the advantage of certain professors and departments and against a fair deal for other professors and departments. (2) I think the election of a president by the faculty might be an improvement on the present system. The matter of the salary of the president should be adjusted to circumstances. It is to be presumed that the president has unusual expenses by reason of his office, which unless allowed for, might result in only wealthy men being able to take the position. It seems to me the president should have powers greater than the professor, but perhaps only those which pertain to the chairman of a meeting acting in accordance with parliamentary rules. I would grant him veto power in regard to financial measures. (3) Agreed to, except that a department or division may be able to conduct its affairs wisely when the number of members is less than the minimum of ten prescribed by the "psychological constant." (4) Agreed to. (5) Agreed to. My chief objection to a change from the present system of placing the

control of measures involving expenditure in the hands of non-faculty members of the university lies in the innate division of professors into two groups, those with dominant administrative powers and secondary intellectual accomplishment in their professed field of work, and those with dominant studious habits and without aggressive worldly mindedness such as characterizes the administrator busy with the affairs of his fellows. In the proposed plan it seems to me that the chances are that certain groups of men would more than now develop onesidedness in the policies of a faculty, and that academic politics would receive an additional impulse. But I may be mistaken in this suspicion. The right of the individual professor to vote for representatives should safeguard him in this matter and on the face of it the plan seems to give fair play.

Naturally I do not wholly agree with the proposed plan. I think it is fair to say, however, that I am wholly in sympathy with the spirit of the plan and should agree that our present autocratic government may profitably be modified in the directions which you mention. I suspect that many modifications of the plan would be suggested in connection with any attempt to put it in operation. As I understand your proposition, the chief problem is one of the rôle of the president, and in this I should heartily agree with you that scholarship and research, at least, are likely to be far safer and much more advantageously promoted under the type of administration which exists in European universities than under our own. A wise autocrat may do much to foster the life of a university, but ideal men for such positions are so rare that it seems little less than absurd for our American institutions to continue their present form of administration. I most heartily approve of division organization. With certain slight modifications we might have at Harvard a very efficient organization of this sort, but of course at present all such division units are subordinate in a great variety of ways to the president. One of the most urgent needs in

our institutions, it seems to me, is a good method of choosing professors. This, I think, is wisely provided for in your plan. On the whole, I should favor experiments in the directions which you have indicated and should confidently expect that our university government might be very markedly improved. I feel that we need to take account both of American conditions and of the forms of government which have been thoroughly tested, especially in England and in Germany.

I am in sympathy with much you state in this article and fully in accord with many of your views. The question is complex, especially as between state universities and "private" universities.

I believe it would be impossible to foretell what would be the outcome of such a scheme for university organization as you propose, if applied to our American universities. The present situation needs a remedy and your scheme has so many good points that I would favor a conservative trial of it. I am sure that the last sentence on flexibility and anarchy is what we should all strive for.

I agree with most of your suggestions. In my opinion it is practically impossible for the president of a university intelligently to preside over all the different faculties of the university.

The plan of university control outlined in your enclosure appeals to me as admirable in striving to develop a more equable division of effective powers between faculty and president than obtains in most universities at present.

I am entirely in sympathy with your effort toward the administrative improvement of our universities. Professors ought not to be employees but members of the firm.

I sympathize heartily with the views in regard to university control which you propose, but do not feel competent to discuss the entire subject, especially paragraphs (1) and (2). I may say, however, that I have always felt that a small self-perpetuating corporation,

such as that at Harvard, without age limit for its "fellows," although all members of the university are considered incapacitated at sixty-six or thereabouts, is inherently wrong and altogether autocratic. The corporation should be selected by the alumni, by the general body of instructors, or better perhaps by both, and I doubt much if the appointment should be for life.

I am quite in accord with the scheme proposed and raise a question only concerning one point which is included in (4). While in thorough sympathy with the democratic mode of control, I doubt its efficiency. In such departments as I have been connected with, the lower positions are filled more or less temporarily by men who expect to pass on to other higher positions. They have not the responsibility for the department, as is the case with the professor, and as far as my experience has been, they lack interest in the matter of appointments and policy. Furthermore, they are not acquainted with conditions and men to the extent that the head of the department must be in order to make his department a success. In fact, I believe that the head of the department must be "czar" or "boss," so to speak, and those under him must be responsible to him in order to make such a unit a success. In fact, the executive work of a department in my opinion, must be attended to by its head or a person representing him. On the other hand, I believe that it is important that all matters pertaining to the department should be discussed freely by all concerned, and of course in regard to scientific matters there should be the utmost freedom. We have an organization with the unit similar to that outlined in your plan, and it strikes me that there is apathy and a general lack of interest among the younger men.

I heartily approve the general principles of your plan of university control. A plan which secures a separation of the financial and the educational administration is, in so far, a vast improvement over the prevailing plans which ordinarily assume that one gov-

erning body may be expert both in business affairs and in educational matters. I favor, too, the more democratic control secured by your plan. I fear, however, that the corporation provided for in (1) of your plan might easily be too large and too freely constituted to be efficient. I should consider it highly unsafe to let the corporation include any "members of the community" who might be pleased to "ally themselves with it" and "pay annual dues." There should be some fairly rigid qualifications for membership designed to exclude all who are not willing to give much of their time and energy to the upbuilding of the university. I see no important function in the office of a chancellor. Why should not the president best "represent the university in its relations to the community," for the university is essentially an educational institution—not a business institution? The further details of your plan, as set forth in (2)-(5), I favor without important exception. The plan of electing professors seems unnecessarily complicated perhaps. Here at Harvard the small division or department enjoys a high degree of autonomy, especially in matters of educational nature, much as your plan proposes. I trust that your agitation of this matter may serve to direct the evolution of our universities along more desirable lines.

In regard to your interesting scheme for university control, paragraph (1) I agree with (with the possible exception of the "members of the community who ally themselves with it"). Would not the alumni of the established university be enough representation? I also agree with paragraph (2). The office should be yearly, or for not more than two years, regarded as a position of dignity, and the election come from the faculties. He should be paid during this time more than a professor, because his work will be greater, more bothersome; he will have to attend functions and dinners and should be compensated for this, particularly for the dinners. In paragraph (3) the unit of organization should be the different faculties. I am not sure about the representation in this, but I think that the

representatives should be the heads of the various departments, the men who are really responsible for the character of the work in each department. There is a difficulty here with regard to the very large departments, such as history, literature or chemistry in a university. It might be difficult here to single out the one responsible man. The other plan would be by the election of representatives by the departments of the faculties. This would probably be necessary in the philosophical faculty. The maximum of representatives for each faculty should not be more than twenty. In paragraph (4) I agree fully with regard to the election of the dean and the nomination of professors. The board of advisers I also think is an available feature. One of the great difficulties which I see in university management is that of the removal or non-continuance of inefficient men holding minor positions. Of course, such minor positions, including assistant professors, should be for a term of years and at the end of this term the position should be regarded as vacant and be filled by the best man available. It is much easier to say this than to do it. Certainly in our medical schools and in the hospitals, if a man gets into a minor position he is pretty sure to go on to continual advancement irrespective of the character of his work unless this has been very bad indeed. Nominations by a committee will not obviate this trouble because the committee will not seriously consider this.

The American college president is certainly an anomaly in education; and the wonder is that the system involving him works on the whole so well. Certainly university faculties do not seem well qualified to manage universities; and state or national educational boards are to be dreaded—Heaven save us! Does not the existence of the present system show that faculties are unbusinesslike and are willing to have some one manage for them? The present method presents a strong contrast to that of the directors of a mill or manufacturing company—where the matters germane to the industry are discussed by a board of

directors with a president who is the executive officer. Imagine the feelings of the directors if the president should go to another body, on which the directors have no representative, and state the opinions of the directors as he understands them, or as he desires them to be understood. This is the condition in most of our universities. The faculties should shape the educational reforms of the universities—in a council consisting of not more than twenty men—heads of great departments. The president should carry the votes of such a council to the business and legal councils of the university to ascertain if there are practical objections to the plans of such an academic council. Why should one man assume to shape the educational future of a university?

It seems to me that the cooperation of all faculty members above and including the rank of instructor, should be desired, but how to get this is not clear to me. If the appreciative sympathy of all the faculty is not had, the control surely will go to the "old guard" and there it will remain, not permitting the careful and at the same time progressive policies essential to the health of the university, as a whole, or it will be taken over by some clique, which would be equally undesirable. Perhaps the end could be best attained by the adoption of a near-republican form of control, by which as much authority as feasible could be delegated, but in which all faculty members including instructors should have the right to vote and should be eligible for service on appropriate committees. The chief executive officer should be elected by this voting body, and for a definite term of years. The professors should also be elected by the same body, but for an indefinite period. I have no comment to offer on your suggestions except the single one, that they appear to me to be sound in every particular and worthy of serious consideration. Such universities as have barely escaped shipwreck through the use of wrong policies in control could well follow the plan laid down by you with great profit.

SCIENTIFIC BOOKS

Vergleichende Anatomie des menschlichen Gebisses und der Zähne der Vertebraten.
Von Dr. PAUL DE TERRA. Jena, Fischer.
1911. Pp. v+451. Mit 200 Textabbildungen.

Thoroughly Germanic is the stamp of this work: in its tireless massing of details, in its bibliography of three thousand titles and no less in its comparative anatomy.

The author, Dr. Paul de Terra, "vorm. Zahnarzt in Zürich," has not been content to regard the human dentition solely as the subject matter of a lucrative profession, but conceives odontology rather as a branch of morphological science. After a section devoted chiefly to the masticatory apparatus of vertebrates and to the development of the mouth cavity and its parts we find an apparently reliable account of the dentition in general, dealing with the macroscopic and microscopic form, the development and calcification of the milk and permanent dentitions, the mechanism of replacement, the reduction and degeneration of teeth, supernumerary teeth, chemical composition of the dental elements and the like.

The author is of the opinion that odontology is still very largely an empirical science with no great number of well-founded doctrines. He says it is difficult, in view of the multitude of controversial matters, to write a consistent text-book of odontology. He has, therefore, striven to state all sides of the controversial questions with great impartiality. This is perhaps the reason why matters relating to evolutionary origins are left in such great uncertainty and why the now well-discredited and thoroughly archaic hypothesis that the molars of mammals arose through the concurrence of single peg-like teeth is treated with so much respect.

The "theory of trituberculy" is very briefly expounded, but without help from Osborn's later researches, especially "The Evolution of the Mammalian Molar Teeth," 8vo, 1908, which the author does not quote even in his bibliography. It is to be hoped that some day writers of text-books on zoology and odontol-

ogy will become aware that the strong and well-founded part of the theory of trituberculy is *not* the view that the tritubercular molar arose from the triconodont and protodont types through "migration of the cusps"—a view that rests upon the slenderest of analogical evidence.

Another desideratum is the final rejection of one of the early trituberculy diagrams (reproduced on page 62 of the work under consideration) which has unfortunately gained a wide currency in text-books. This diagram, which purports to show the spatial relations of the cusps of the upper and lower molars when in contact, is thoroughly misleading, because no teeth known fit together in the way there represented. In every tritubercular-tuberculo-sectorial dentition, as well as in derived types, the protocone of each upper molar fits squarely into the talonid and behind the trigonid of the corresponding lower molar; as the hypocone is developed it reaches into the valley of the trigonid of the next following lower molar. Primitive Marsupials, Rodents, Insectivores, Carnivores, Primates, "Ungulates" of all orders, all conform to this rule, which furnishes a complete clue to the spatial relations of all parts of the upper and lower molars when in contact. As the reviewer has elsewhere shown, this fact has an important bearing on the derivation of the tritubercular dentition. The alternating relationship of the parts of the upper and lower molars was probably established very early in the history of the Mammalia and is indeed clearly foreshadowed in some of the extinct mammal-like reptiles of South Africa (*e. g.*, *Diademodon*, *Sesamodon*).

It is unfortunate that the author with all his diligence should have made so little effective use of contemporary vertebrate paleontology which might have furnished him with a well-organized method of interpreting at least in part his great compilation of undigested facts about the dentition of fishes, amphibians, reptiles, birds and mammals, a subject covering about 200 pages of the present work. If one wishes to know how many teeth

there are in the jaws and of what kind they are, in recent forms and in a good many fossil forms, he will most likely find here a careful statement of the facts, which is after all the professed purpose of the book. Certain it is, however, that such odontographical information is merely the beginning and not the end of odontology, conceived as a division of comparative anatomy.

WILLIAM K. GREGORY

Modern Industrial Chemistry. From the German of H. BLÜCHER. Translation by J. P. MILLINGTON, M.A. (Cantab.), B.Sc. (Wales), formerly Scholar of Christ's College, Cambridge. The Gresham Publishing Co., 34 and 35 Southampton St., Strand, London. 1911.

According to the publisher's note, this volume is put forward as a standard work, now for the first time issued in an English translation, designed to cover the whole range of subjects with which the chemist and manufacturer are usually concerned. It is not intended as a text-book, but to occupy a position between the text-book and the lexicon. It is arranged in strictly alphabetical order and should therefore be regarded as a dictionary of chemistry.

It is conveniently issued in a single volume of 780 pages. With the exception of the convenience of having a compendium of this sort issued in a single volume, it is difficult to see in what respect this work presents any advantages over the standard dictionaries of chemistry such as those of Thorpe and Watts. It certainly can not be called up-to-date. Many of the leading industrial processes and products are not well handled, especially from the standpoint of American industry. The treatment of the chapter on industrial alcohol, for instance, is not in accordance with the best modern information, and the same may be said of the article on sugar manufacture. Under the descriptions of asphalts, petroleum, tars, etc., many of the statements seem arbitrary and misleading from the standpoint of American technology. The translator has evidently found considerable difficulty in find-

ing synonyms for German technical names and phrases. The properties of both asphalts and tars, as related to their residual products, now so much used for paving purposes, are inadequately treated, and unimportant patented preparations seem to be given too much prominence. Water gas tars, for which considerable uses have been found, are not mentioned in the volume.

Under pigments and oils, we find a very fair but brief description of the various dry colors, mineral and artificial, as well as pigments used in the manufacture of paints. The treatment of the manufacture of white lead is, however, very old, and does not include any mention of the new processes now in use both in America and abroad, such, for instance, as the Rowley or the Picher processes. All of the more common oils and thinners for paints are briefly described, and considerable matter concerning the manufacture of varnishes is included. The newer paint oils which have come into prominence of late years are not mentioned.

Metallurgical processes are described only briefly, and for the most part the descriptions do not adhere to the usual or best practise common in American metallurgy.

Perhaps the most useful feature in the volume is comprised in the digest of foreign and local patents, which touch upon a number of the principal subjects cited and which afford considerable data for reference purposes. The book is well printed and presents an attractive appearance. It will undoubtedly be a valuable addition to a reference library for the chemist or manufacturer, but should not be accepted as authoritative or up-to-date in all the numerous subjects which are covered.

ALLERTON S. CUSHMAN

SCIENTIFIC JOURNALS AND ARTICLES

THE April number (volume 13, number 2) of the *Transactions of the American Mathematical Society* contains the following papers:

G. A. Bliss: "A generalization of Weierstrass's preparation theorem for a power series in several variables."

W. D. MacMillan: "An existence theorem for periodic solutions."

W. F. Osgood: "A condition that a function in a projective space be rational."

J. C. Fields: "A method of proving certain theorems relating to rational functions which are adjoint to an algebraic equation for a given value of the independent variable."

M. B. White: "The dependence of focal points upon curvature for problems of the calculus of variations in space."

J. E. Hodgson: "Orthocentric properties of the plane directed n -line."

S. E. Uner: "Certain singularities of point transformations in space of three dimensions."

J. R. Conner: "Multiple correspondences determined by the rational plane quintic curve."

THE March number (volume 18, number 6) of the *Bulletin of the American Mathematical Society* contains: Report of the winter meeting of the Chicago Section, by H. E. Slaught; "An identical transformation of the elliptic element in the Weierstrass form," by F. H. Safford; "Surfaces in hyperspace which have a tangent line with three-point contact passing through each point," by C. L. E. Moore; "Note on mixed linear integral equations," by W. A. Hurwitz; "Note on the graphical solutions of the fundamental equations in the short methods of determining orbits," by A. O. Leuschner and B. A. Bernstein; "On a functional equation," by A. R. Schweitzer; "Shop mathematics," by C. F. Warner with rejoinder by C. N. Haskins; "Shorter Notices": Dumont's *Arithmétique générale*, by N. J. Lennes; Schur's *Grundlagen der Geometrie*, by F. W. Owens; Appell and Dautheville's *Introduction à l'Etude de la Physique et de la Mécanique appliquée*, by J. B. Shaw; Crelier's *Systèmes cinématiques*, by Arnold Emch; "Notes"; "New Publications."

THE April number of the *Bulletin* contains: Report of the February meeting of the society, by F. N. Cole; "On the foundations of the theory of linear integral equations," by E. H. Moore; "Shorter Notices": Young's *Fundamental Concepts of Algebra and Geometry*, by E. B. Lytle; Friedel's *Leçons de Cristal-*

lographie, by J. B. Shaw; Andoyer's *Nouvelles Tables trigonométriques fondamentales*, by E. W. Brown; *Annuaire du Bureau des Longitudes pour l'An 1912*, by E. W. Brown; "Notes"; "New Publications."

SPECIAL ARTICLES

TERTIARY DEPOSITS OF EASTERN MEXICO

OUR investigations during the past year on the eastern coast of Mexico have brought out very important facts in connection with the historical geology of the Gulf Coast.

As stated in this journal a year ago,¹ deposits which are lithologically and faunally the same as those referred to the Eocene in the Texas Coastal Plain were traced southward through northeastern Mexico to the Conchos or Presas river. Fossils characteristic of substages of the Texas Claiborne were found on this river, and beyond it the sediments were traced southward to a point a few miles north of Abasola, where they passed from sight beneath the overlap of the San Fernando Oligocene. The materials of the Eocene throughout this region are clays and sands in all respects similar to those of the Texas area and the fossils are species practically identical with those of that region.

The materials of the Oligocene are yellow clays and sands with thin beds of impure limestone, carrying an abundant fauna. These beds are not represented at all in the Texas area between the Brazos and Rio Grande. If they were ever present they have been eroded or concealed by the overlap of later beds.

From the point north of Abasola, where the San Fernando is found resting upon the Papagalloes shales of the Cretaceous, this contact continues southward along the eastern border of the valley of the Soto la Marina river to the town of the same name; then it parallels the eastern flank of the Tamaulipas range, drawing gradually nearer the Gulf shore until, in the vicinity of Tordo bay, the Cretaceous is found within 8 miles of the coast.

¹ SCIENCE, Vol. XXXIII., No. 841, pp. 232-234.

No deposits in any way similar to those of the Eocene of this northeastern region have so far been observed south of Abasola, which is 120 miles north of Tampico. The last characteristic Gulf Coast Eocene fossils were found on the Presas river 160 miles north of Tampico.

In the region to the south and west of Tampico an entirely different condition exists. The Papagallos shale continues along the western border of the lowland and also occurs as inliers in the later formations. It is a compact blue shale, more or less calcareous, and up to the present we have found no fossils in it.

It is succeeded by a shale so similar in color and general structure as to make a separation extremely difficult, unless one is fortunate enough to find the fossils which occur here and there in it. One such locality is that on the Buenavista River near Alazan, some 25 miles northwest of Tuxpam and 75 miles south of Tampico. A collection of fossils made at this point by Professor Cummins shows a fauna consisting principally of small gasteropods with a few bivalves, many of which are very similar to, and some identical with, those of the Tejon beds of the Pacific coast. More detailed examinations will doubtless result in recognizing these beds at many other localities, since they unquestionably underlie a large area. They may even extend northward through the valley in which the Tampico and Monterey railroad runs, since we found similar fossils in a well at Topila at a depth of 1,810 feet. From this locality we have the following forms as determined by Mr. G. C. Gester:

1. *Dentalium stramineum* Gabb.
2. *Surcula monolifera*.
3. *Turris* n. sp. (near but not *Claytonensis*).
4. *Olivella* near *matthewsonii*.
5. *Corbula* (species not determined but identical with a specimen from Marysville Buttes Tejon).
6. *Tritonium* (*Murex*) n. sp. (identical with material from Marysville Buttes Tejon).
7. *Conus remondii*.

8. *Neverita secta* or *Lunatia hornii* (Gabb).
9. *Neverita secta* var.
10. *Tritonium* sp. (identical with specimen from Marysville Buttes).
11. *Turris* n. sp.
12. *Turritella*.
13. *Cerithium*.
14. *Eulina*?
15. *Acteon*?

Out of the fifteen species here enumerated, five are identical with Tejon species and six others are very closely related to them.

Not only are the fossils of this area of Pacific coast types but the sediments are similar to those of that area and entirely different from those of the Texas region.

These Alazan shales are overlain directly by the yellow clays of the San Fernando, which are well exposed both west of the Buenavista River near Alazan and eastward between Solis and Meson. Large quantities of fossils are found, including *Orbitoides papyrycæa*, echinoderms, pectens and many species of this as yet unstudied fauna. These yellow clays and sands are the surface material over a large portion of the coast country between Tuxpam and Tampico and its fossils were found at a number of places in this area. It is succeeded by beds of similar composition but later age, which are found only in a narrow belt along the coast itself.

It appears that from the beginning of the Oligocene to the Pliocene there was comparatively little change in the character of the sediments, yellow clays and sands making up the bulk of the deposits. The difference of age is, however, marked by change in faunas and the San Fernando is succeeded by the Tuxpam Miocene, which we found near La Loma.

The time equivalency of the Tejon and Claiborne being probable, we find here apparently contemporaneous deposition of the Atlantic and Pacific types of middle Eocene along what is now the same Gulf coast within a comparatively short distance of each other. While we have not yet had time to study the Tamaulipas range with this idea in view, it appears probable that it may represent a part

of the old barrier between the two basins in which this deposition was carried on.

E. T. DUMBLE

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 461st regular and 33d annual meeting of the society was held on April 30, at 8 P.M., in the new National Museum, with the president, Mr. F. W. Hodge, in the chair. The following officers were elected:

President—Mr. G. R. Stetson.

Vice-president—Mr. Francis LaFlesche.

Secretary—Mr. William H. Babcock.

Treasurer—Mr. J. N. B. Hewitt.

Additional Members of the Board of Managers—Messrs. G. C. Maynard, Felix Neumann, E. T. Williams, Drs. E. L. Morgan and John R. Swanton.

The following amendments to the by-laws were adopted:

Art. I., Sec. 1, to read: "... Its members shall be classed as Active, Life, Associate, Corresponding and Honorary."

Art. I., Sec. 2, for the words "This sum . . . January" the following to be substituted: "Members elected at any time during the first half of the calendar year shall pay the full amount of their annual dues; those elected during the last half of the year shall pay one half the regular annual dues."

Art. I., Sec. 3, to read: "Associate Members are those who, after having been elected, shall have paid the annual fee. The annual dues for Associate Members shall be Two (\$2.00) Dollars for each calendar year, payable in January. This sum entitles them to all rights and privileges of the Society with the exception of the *American Anthropologist*."

Old sections, 3, 4, 5, 6, 7, to read 4, 5, 6, 7, 8.

Art. I., Sec. 5 (formerly Sec. 4), "Proceedings" to be substituted for "Transactions"; "or associate" to be inserted after "active"; "those classes" to be substituted for "that class."

Art. I., Sec. 6 (formerly Sec. 5), for "Transactions," read "Proceedings."

Art. II., Sec. 4, for "quarterly" read "annual"; for "transactions" read "proceedings."

Art. III., Sec. 1, for "alternate Tuesdays" read "third Tuesdays of each month."

Art. III., Sec. 3, after the words "Board of Managers" insert "the President."

Art. III., Sec. 4, insert after "President," "or at the recommendations of three members of the Board."

Art. VI., Sec. 1, to read: "These by-laws may be amended by a three-fourths vote of the Active, Associate and Life Members present at any officially appointed meeting of the Society, provided notice of the proposed amendment shall have been given, in writing, at a meeting held not less than sixty days previously."

TRUMAN MICHELSON,

Retiring Secretary

THE PHILOSOPHICAL SOCIETY OF THE UNIVERSITY OF VIRGINIA

AT the regular monthly meeting of the Scientific Section of the Philosophical Society, held on April 15, 1912, Professor W. H. Echols presented a paper "On the Flow of Water in Artificial Channels, Clean Pipes." The paper may be summarized briefly as follows:

The paper continued the investigations presented two years previous, by proceeding to another degree of precision with wider range of application. The result gives for Chezy's coefficient of resistance m in the expression for loss of head in clean pipes

$$h = m \frac{L}{r} \frac{V^2}{2g},$$

the value

$$m = \frac{.0094 + \frac{.00003}{\sqrt{r}}}{1 + \frac{.07V}{1 + \left(\frac{.015 + \frac{.002}{r}}{r} \right) V} + \frac{.6r}{r + .1}}$$

r being the mean hydraulic radius and V the velocity expressed in feet and seconds. This value of m applies to the whole class of clean pipes of easy curvature, of glass, brass, tin, lead, zinc, cast and wrought iron coated, riveted iron coated with asphalt. For straight new asphalt coated cast-iron pipes the velocities from the formula should be increased five per cent. and for wooden stave pipes ten per cent. Four hundred experiments were tabulated in the paper with diameters from one tenth of an inch to eight feet and velocities ranging from two tenths to fifty feet. Three graphical plates accompanied the paper drawn to large scale, giving corresponding values of the coefficients m and c and the relations of V , r and s the hydraulic slope. The paper will be published in the *Transactions* of the society, Bulletin No. 10, Scientific Series.

R. M. BIRD,

Secretary

SCIENCE

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VOL. XXXV. No. 911

FRIDAY, JUNE 14, 1912

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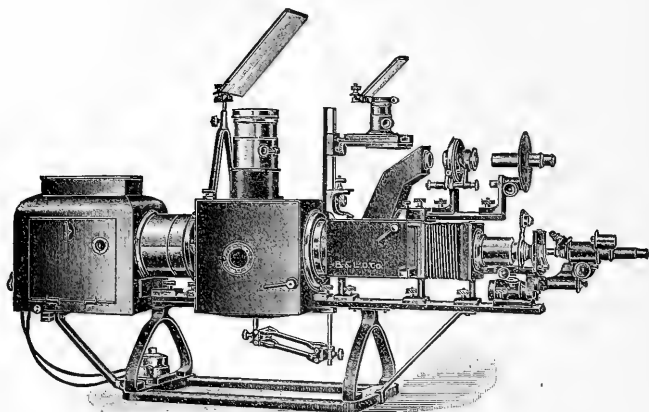
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SOME CURRENT CONCEPTIONS OF THE GERM PLASM¹

It is a commonplace of observation that the first decade of the present century has been, so far as the study of heredity and the germ plasm is concerned, a period of observation and experimentation, rather than of theorizing. The speculations as to a physical basis of heredity and its ultimate structure, which began with Naegeli's conception of the idioplasm and micellæ and culminated in Weismann's elaborate system of ultra-microscopic bearers and determiners of heredity and development, have given place to a renewed activity of observation on the structure and functions of the cell in reproduction and especially to experimentation in hybridizing and all forms of plant and animal breeding. We need not go so far as to say that evolution was on its death bed before the Mendelian revival. The study of the ultimate structure and processes of the plant cell has gone on from Von Mohl's time at least without much regard to such highly speculative disciplines as natural selection, Neo-Lamarckianism, neo-vitalism, etc.; still there can be no question that with the rediscovery of Mendelism and the possibility of bringing a great mass of both breeding and cytological data, as to unit characters, gametic purity, segregation and germinal variation and the behavior of the chromosomes in nuclear division and fusion, synapsis and reduction, into one harmonious theory of development, a great impetus has been given to the study of the funda-

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¹ Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, December, 1911.

mental problems of cell behavior and heredity.

The relative share in this stimulus to renewed and hopeful study of the facts which is to be assigned to the older theories of the germ plasm and to the new observations of mutation, dominance, segregation, synapsis, etc., is a question which may be left to the historian of biological science in the future to determine. There can be no question that De Vries's theory of pangenesis has guided in large degree his experimental studies in mutation.

It will certainly be of interest to attempt to discover how the new observations are related to the older theories of the germ plasm and especially to try to learn how the numerous experimenters and breeders who are putting forth such a flood of data on hybridization, pure-line breeding, bud variation, graft hybrids, etc., find it necessary to modify or discard and replace the terms and conceptions of the older theories in order to give an intelligible account of their observations.

The theories of Naegeli, Darwin, Weismann and De Vries can all be characterized as Detto and others have made clear, as corpuscular theories of heredity and organization more or less frankly based on an assumed analogy between the ultimate constitution of matter as given in the atomic theory and the grosser mechanical organization of living plants and animals. The fate of this assumption in the hands of experimental breeders and students of the cell is certainly a matter of great interest.

We may first note that the outcome of all this activity of research, both in cytology and breeding, has made it increasingly certain that we do have in the permanent structural constituents of the nucleus a real physical basis of heredity. The evidence available ten years and more ago,

that the chromosomes transmit the hereditary characters of the adult organism in so far as they are directly transmitted, which is based on the permanence of the chromosomes through successive generations, due to their method of reproduction by equational division, their constancy in size, number, shape and position in the germ cells, however the latter may differ in shape, motility, cytoplasmic mass, etc., has been continually strengthened as the result of a more careful analysis and interpretation of results.

The attack on the specific character of the chromosomes and their reproduction by splitting, which has been made in the contention repeatedly appearing from both botanists and zoologists, that nuclei may divide by so-called direct division, that is, simple constriction, and still continue capable of perpetuating the species, has in every case on more careful study been found to be due to faulty interpretation or inadequate methods of observation. Only a passing reference to the exploded notions of Pfeffer as to *Spirogyra* and Child as to certain flat worms is necessary in this connection. Cases of apparent preponderance of the female, such as the echinoderm hybrids, in which the enucleated egg cytoplasm determines the type of cleavage and early embryonic development, are always those in which the egg has become a highly specialized cell by reason of the accumulation of yolk stuffs, etc. That a cell so enlarged should have also developed what has been called a promorphology is natural enough. That this preconjugation organization is that of the species to which the egg belongs is inevitable, but such cases can have no final significance in determining the question of the relative functions of nucleus and cytoplasm in heredity. Perhaps the best recent evidence that elements of the cytoplasm may also

belong specifically to the germ plasm is found in Meves's observation of the so-called chondriosomes which he finds widely distributed in the tissues of the embryo chick and so evenly scattered in the cytoplasm of each cell that they are somewhat equally allotted to the daughter cells in division. That these bodies may be concerned in heredity is however hardly more than an interesting suggestion. That any considerable portion of their material is really derived from the male gamete is certainly not proven. In sexual reproduction they are as yet to be classed with the ordinary cytoplasm. That they are, however, widely distributed cell organs seems probable. Unpublished observations in my own laboratory show that they are present in the embryonic muscle, connective tissue, cartilage and nerve cells of trout embryos with the same appearance and apparently the same relation to the formation of muscle and nerve fibrils, etc., which has been described by Meves for the chick. That similar structures are also present in embryonic tissues of plants seems probable from the recent preliminary announcement and figures of Guilliermond showing their appearance in the embryonic cells of the kernels of the cereal grains thus confirming the still earlier observations of Bigaud and Lewitsky. That they are in reality *anlagen* for the cell plastids needs further proof, of course, but that we have in them an important and widely occurring stage in the differentiation of embryonic cytoplasm into the characteristic organs of specialized cells in both animals and plants is strongly suggested. Their study may be expected to throw further light on the methods by which the material transmitted by the germ cells comes to its expression in the structural features of the adult tissues.

Other minor objections are being urged

repeatedly against the doctrine, but in my opinion it must be taken as one of the best established facts of cytology to-day that there is a specific germ plasm differentiated from the general protoplasm of the cell, and that this specific plasm is at least carried by and continuously present in the stainable materials of the nucleus. From the cytological side, evidence has continually increased that we have in the chromatin of the nucleus a physical basis of heredity in a very specific sense.

When we turn to the interesting question as to how far the laborious and widespread cytological studies of the past decade have gone toward confirming the earlier corpuscular theories as to the ultimate structure of this germ plasm, we are confronted for the most part as yet with negative results. It can be claimed by no one that there is any substantial agreement among students of the cell to-day as to the existence even of any visible organized structure in the chromosomes themselves. Heidenhain is the most effective recent defender of the theory of an ultramicroscopic organization of the cell and nucleus, but his arguments for the existence of a bio-system below the grade of the chromosome represented by chromioles and centrioles has met with no general acceptance. As Haecker affirms, there is no agreement as to any facts of structure in the chromosomes themselves. The existence of the chromioles as specific units has not been confirmed. Errera has made it clear that bodies of the size of the chromomeres could contain only some thousands or less of proteid molecules, according to the chemical evidence, and it is hardly possible that an organization of any significance could be achieved with so few units. It is not impossible that in the chromosomes we have reached the ultimate units in the organization of the cell, themselves not or-

ganized, but purely chemical aggregates. Certain it is that the strands and granules and the spongy, knotted structure shown in the drawings of the chromosomes by the best cytological students of the day agree superficially in some respects at least with the descriptions of the colloid chemists of the structure of two-phased colloidal systems.

On the other hand, our knowledge of the chromosomes as independent continuously perpetuated organs of the cell has been enlarged and confirmed from many sources.

The extreme form of the doctrine that the chromosomes are independent individual organisms, cells within the cells, is probably an exaggeration, but evidence has continually accumulated that the chromosomes are specific and permanent parts of the cell which are formed only by the division of already existent chromosomes and which are nourished and grow after division so as to maintain within certain limits a size and number characteristic for each species. From the cytological standpoint also the argument for the significance of the serial arrangement of the chromosomes in the splitting spirem has lost none of its force.

The importance of the conclusion that each species has its constant number of chromosomes has only been emphasized by the discovery of cases in which such differential qualities within the species as distinctions of sex are found to be accompanied by a corresponding difference in the number of chromosomes in the two sexes. To be sure, such an extreme germinal difference as the presence of an additional chromosome in the female is probably a rare case found so far chiefly among insects. But the fact that in these cases the structural and functional differences between the sexes in the adult form are correlated with specific differences in

chromosome number in the germ cells must be regarded as strong evidence that the chromosomes represent in some fashion the hereditary characters in the germ cells.

It may well be expected that other slight differences in chromosome number which have been observed within the species will be found to have quite as rational and natural an explanation as have the sex chromosomes. Other forms of dimorphism may perhaps be dependent on corresponding variations in chromosome number or size.

In the case of the sex-chromosomes the question as to how the organs and characteristics of the adult can be represented in the germ plasm is raised in a very concrete form. If the presence of an extra chromosome determines the female sex, it must apparently not only represent the specific female sex organs of the adult, but also a series of secondary sexual characters belonging to the other organs and tissues. The difficulties involved in any corpuscular theory of heredity become conspicuous in such a case. That a series of granules representing *anlagen* for all the various characteristics of the female sex should be brought together in a single chromosome, being thus apparently separated from all the other *anlagen* for the organs which show secondary sex characters, and should still be able to determine the development of the individual in all these respects, is scarcely conceivable. The discovery of the sex chromosomes must be regarded as evidence against the corpuscular theories of heredity.

The view that characters that are sex-limited in heredity must also be determined by materials which accompany or are included in the sex chromosomes makes the situation still more difficult, being quite inconsistent with even a serial arrangement of the elements of the germ plasm

such as the cytological facts as to the longitudinal splitting of the chromosomes seem to demand, and shows how inconsistent with the assumption of even the simplest form of determinate arrangement of elements in the germ plasm Mendelian conceptions are. It is obvious that the couplings seen in sex-limited inheritance suggest the connection of the factors representing them with a sex chromosome. That is why such characters are called sex-limited. But to actually imagine such diverse and easily transferred characteristics of color, etc., affecting such widely separated parts of the adult organism as inhering in or connected with a single sex-chromosome is just as obviously opposed to the common interpretation of the serial arrangement of the chromosomes and their parts. Other cases of Mendelian couplings, such as that of long pollen and purple flower color, are just as inconceivable on the basis of a serial corpuscular representation of genes in the chromosomes. To be sure, Bateson is now inclined to give up the conception of gametic coupling, but the idea has been widely taken up and seems fairly well established among Mendelian conceptions. It differs little, of course, from the older ideas of correlation in heredity. The factors in heredity in such cases are certainly more easily conceived as due to the characteristic constitution of the germ plasm, as a whole, than as represented by unit corpuscles.

One of the strongest pieces of cytological evidence that the number of the chromosomes is due to their own specific and individual characters, rather than any mere mechanical necessities in the cell organization, such as Fick assumes in his maneuver hypothesis, is found in the work of the Marchals on aposporous mosses. By regenerating the gametophyte directly from the sporophyte without the

intervention of the reduction division (apospory) they have produced diploid gametophytes. These in turn in fertilization have produced tetraploid sporophytes, and these by regeneration again tetraploid gametophytes. No stronger evidence for the permanence and independence of each chromosome could be produced. An excess of chromosomes can only be gotten rid of by a specific reduction division, that is, by separating them without the splitting of each into two. Some of the diploid gametophytes seemed vigorous, the tetraploid gametophytes were weak, and the physiological limit for the number of chromosomes in one cell was probably reached in them. These cases, along with those in ferns, show that an excess in the amount of the germ plasm doubling or trebling the representation of each hereditary quality need not necessarily affect the morphological characteristics of the organism, and are in strong contrast with such cases as that of *Oenothera gigas* and certain races of bananas, in which a doubling or trebling of the chromosome number is associated with marked structural changes in the plant. When the excess number of chromosomes fails to produce visible effects, the condition is perhaps analogous to that of ordinary latency. The condition of ineffectiveness of the excess chromosomes in these diploid and tetraploid gametophytes of the mosses, so far as their relation to morphogenetic processes is concerned, also seems analogous to that of the chromosomes of the recessive parent in the F_1 generation in cases of Mendelian dominance. Cells containing two complete sets of chromosomes may show complete resemblance to one parent or mixed, mosaic and intermediate resemblance, depending on the degree of prepotency or latency represented by the conflicting sets of chromosomes. Mendelian dominance and re-

cessiveness represent the extremes of prepotency and subordination in the relations of the diploid germ plasm.

Such evidence as this suggests that the germ plasms are related to each other much as competing races of organisms are. The evidence here may be said to favor the idea of the germ plasm as a mass of independent individual corpuscles competing with each other for their existence. One of the most obvious ways in which Mendelian concepts have influenced the idea of the germ plasm is in the emphasis which the idea of Mendelian dominance gave to the conception of antagonistic relations between its elements. Of any two characters present in the parents, one may dominate the other in the offspring without destroying it. These facts are obviously opposed to a chemical theory of the germ plasm. If the union of the two factors is chemical it should result in some new compound with properties in some degree different from either. As has been pointed out by Friedmann on chemical analogy, the product of the union of two germ plasms would not necessarily be intermediate in its properties between those of the two combining elements, especially in its form and spatial configuration. The angles of a crystal made of a mixture of two isomorphic salts are not the average of the angles of the two components. Such so-called chemical theories of dominance as assume the existence of regulative enzymes influencing the rate of morphogenetic processes by their relative concentration seem to me to beg the whole question by assuming in the appearance of the regulative enzymes at the critical point the element of organization which they start out to deny.

Not only the facts as to constancy and variation in the number of chromosomes, but also our knowledge of their constant

arrangement and position in the cell nucleus, has been greatly strengthened by the critical study of recent years. The accumulating evidence for the constant position of each chromosome in the resting nucleus as it reappears after the disturbance of nuclear division is most suggestive of mechanical organization in the nucleus as a whole, whether or not there be an ultra-microscopic organization of the chromosomes themselves.

Boveri has shown for *Ascaris* that the long chromosomes of the embryonic nuclei reappear at each cell generation in the same position and determine the configuration of the young resting nuclei. In certain fungi at least there is permanent connection between the chromosomes and centrosomes, thus determining the polar organization of the cell as conceived by Rabl. These conditions give strong evidence for a mechanically organized, rather than a mere chemical cell and nuclear structure.

No more important question confronts the students of the cell to-day than the determination of the relative positions of the paternal and maternal chromosomes in the diploid vegetative cells. Evidence that the serial arrangement found in all spirems is maintained in the resting condition and in the equatorial plate of a species of *Carex* will be presented at this meeting. Strasburger, Overton and others find that the chromosomes are paired throughout vegetative development, the members of the pairs representing respectively maternal and paternal elements. If these results are confirmed and found to be general, we have a further vantage point from which to attack the question as to the method by which the parental germ plasms are not only transmitted but come to expression in the offspring.

It is fairly well established that homol-

ogous chromosomes are paired in synapsis, and the prephases of the reduction division. The evidence from cases of chromosomes of unequal length in both animals and plants seems convincing on this point. The determination of the relative position of the parental elements in the vegetative cell generations would go far to settle the vexed question of whether this pairing is side by side or end to end. Without going into the evidence on this point, so many times reviewed in recent years, I may express my opinion that it favors the side-by-side conjugation and, further, indicates that the union of the two parental germ plasms is, in many cases at least, a very intimate one, so that in the pachyneme spireme the visible identity of the two parental elements completely disappears. The discovery that this intimate union of the germ plasms comes at the close of the F_1 generation in the preparation of the germ cells for the F_2 generation forms perhaps one of the closest points of contact between the results of cytological study and experimental breeding. The long-known relative constancy of the first hybrid generation contrasted with the breaking up in the succeeding generations has here its counterpart in the relations of the germ plasms in the reproductive cells.

It seems plain to me also that the behavior of the chromosomes in thus uniting so intimately that their visible identity is lost in the pachyneme spireme, is strongly opposed to the conception of universal and absolute gametic purity and unit characters. It is a very obvious suggestion that the elements of the gametes should not be pure after this union. This obvious suggestion from cytology may clear up the behavior of the offspring from many crossings better than the assumption of more unit factors. The behavior of the parental chromosomes in synapsis and the follow-

ing stages is well calculated to provide for just such fluctuating variability as well as a certain degree of stability as the breeder unbiased by Mendelian preconceptions finds. It is quite possible that in some cases pairs of parental characters may separate or interchange without a trace of mutual influence, but the close union found in the synaptic knot and the succeeding spireme certainly seems adapted to provide the opportunity for a vast amount of modification and interaction between the parental germ plasms.

At this stage again we are confronted in very concrete form with the alternatives of a chemical and mechanical organization of the chromosomes and the difficulties involved in the corpuscular theories become very conspicuous. There is no visible provision in synapsis for maintaining any such space relations between the determinants as Weismann's theory requires, and if we consider the case of the more vaguely arranged pangens of De Vries, it is still at least very possible that chemical reactions might occur between these minute proteid masses so intimately associated as they are.

In the phenomena of reduction, on the one hand, and segregation, on the other, the work of the cytologist and experimental breeder finds a most intimate point of contact, and the results of studies on these phenomena from both standpoints must have the most profound and far-reaching effects on our theories of heredity. The facts of synapsis are even more opposed to complexity of organization in the germ plasm than are the facts of nuclear division which have been so much emphasized.

To understand the present point of view of cytologists and breeders more clearly we must briefly examine the current corpuscular conceptions of the germ plasm. Detto's analysis and criticism of these

views seem to me most suggestive. In his attempts to explain the heredity of form, Weismann conceives a so-called heteronomic structural preformation of the adult plant or animal as existing in his determinants and their architectural arrangement in the germ cell from which it arises. The development of the individual is epigenetic in a sense, but the corpuscular *anlagen* determine the outcome of the series of epigenetic changes. The assumption of all those who hold to a representation of the adult organism in the egg seems to be that if development is really to be explained a complicated spatially differentiated organization must be supposed to exist in the fertilized egg. Hertwig, in his doctrine of epigenetic cellular interaction, also assumes a complicated qualitatively differentiated germ plasma, but these heteronomic preformed structures develop and differentiate themselves under the influence of intercellular and environmental interactions.

Weismann's material determinants are to be described as heteronomic, because there certainly is no visible resemblance between their organization and that of the adult body. It is held that the tissues of the adult body are not to be considered as especially preformed, but that they may be represented in the egg not as formed parts, but as particles in which inhere particular qualities and capacities of the protoplasm. These particles are not identical in organization with the adult characteristic which they determine, but they necessitate the development of that particular adult structural quality. It would seem that the important thing here is the quality or potency rather than the particle, and the difficulty is in assuming complex potentialities as inhering in particles of simple structure. Detto has proposed to call certain of these *anlagen* metidentical,

to indicate that they are heteronomic as regards the actual adult characteristics, but identical with the protoplasmic qualities which are assumed to cause them. Regulative *anlagen* are also assumed which, acting catalytically, perhaps, produce their effects in such fashion that basic protoplasms may be worked out into a product of specific type. It is assumed to be conceivable that form may be due to regulative form *anlagen*. Elements of the cytoplasm forming an internal environment for the germ plasma may act as regulating factors of this sort.

Such doctrines of qualitative preformation aim to explain the architectural arrangements of the adult organism, but as Detto points out, we really explain nothing by simply assuming in the egg a so-called metidentical and heteronomic representation of the structure of the adult. Any organization in the egg which will help to explain the complex and adaptive spatial configuration of the adult organs and tissues must be assumed to possess a similar spatial configuration in three dimensions. In a word, we can explain by our *anlage* no greater degree of spatial complexity than we put into it.

A most striking feature in the assumptions of present-day experimenters is their thoroughgoing break with the conceptions of Weismann as to the existence of germinal elements representing tissues or organs of the adult plant, and in definite space relations with each other in the germ plasma. Many of the factors of the Mendelians have no particular space relations in the adult. Tall and dwarf habits are diffuse characters of the plant, as a whole. Hairiness may be on stem, leaves, calyx, part or all of them. Mendelian hereditary units are not leaves, petioles, stamens, etc., but qualities of these organs or still more diffuse qualities of the whole plant. Fixed

space relations between elements of the germ plasm are quite unnecessary in the heredity of such qualities.

With the disappearance of Weismann's conception of definite and complex space relations between the elements of the germ plasm, we perhaps see the last of the old doctrine of formal preformation. And yet it is a curious fact that one of the most important influences which Mendelian studies have exerted on our conceptions of the germ plasm seems to be in the stimulus which they have apparently given to all corpuscular theories of heredity. The doctrine of unit characters is the real gist of Mendelism, and it seems obvious to associate these unit characters of the plant, as a whole, with the theoretically postulated determinants, granules, etc., of the corpuscular theories of heredity.

The relative popularity of De Vries's conception of the *pangens* is due to the emphasis he lays on the conception of units representing diffuse characters of the plant as a whole rather than organisms or tissues. De Vries's *pangens* are assumed in many cases to represent just such qualities and characteristics of color, size, etc., in the plant as are found to show the Mendelian behavior most perfectly. It is certainly a striking fact that Mendel and De Vries independently reached the conception of the importance of such characters in an analysis of heredity. That De Vries should regard them as units is due to the influence of his corpuscular theory of the germ plasm. They are more properly described as diffuse characteristics of the plant or its organs, as wholes, as De Vries has so strongly emphasized in relating them to the origin of his mutants which differ from their parents in general features affecting the whole organism.

It must be remembered also, that while De Vries makes his *pangens* stand for

characteristic features of the plant or its organs as wholes rather than for specific organs or tissues, and rejects Weismann's and Naegeli's conception of a mosaic combination of the units in a germ plasm, yet he is not free from the feeling that a definite spatial relation of the *pangens* in the germ plasm is necessary. The *pangens* must be in smaller and larger groups and these groups so arranged that the members of a group may become active at the same time at least. The arrangement must also be such as to provide for their proper distribution at each cell division. This sounds as if a relatively simple serial arrangement were all that is necessary, but as noted, the coupling of *pangens* representing all the secondary sex and sex-limited characters affecting widely distributed organs of the body, which in many respects are otherwise determined, with a single sex chromosome or group of *pangens*, is not a simple matter. The doctrine of intracellular pangogenesis, with its storage of *pangens* in the nucleus and their migration into the cytoplasm, provides for the behavior of the Mendelian factors hardly better than the formal unfolding of the architecturally prearranged corpuscles of Weismann's theory.

That the harmony in underlying assumptions between the Mendelians and the adherents of corpuscular theories of heredity is only apparent seems to me the inevitable conclusion of any careful analysis. A list of the characters associated by De Vries with his *pangens* is itself suggestive of difficulties. The first character he mentions in his intracellular pangogenesis is the green color of plants. That this is a characteristic of plants which have a certain unity of behavior in heredity may be true, but to see how it can be represented by a *pangen* granule in the germ plasm so as to appear in just the proper tissues in just the proper degree is not so obvious. Other

pangen characters, such as those for the production of specific alkaloids, oils, tannin, etc., involve the same difficulties, and this is no less true for morphogenetic *pangens* of leaf form, etc. To speak with Klebs, such *pangens* should be potentialities rather than material granules.

The failure of the experimental breeders to characterize more exactly the hypothetical units, genes, etc., in the germ plasm which represent their factors is not all due to a desire for absolute freedom from prejudice in matters of theory, but rather to an inability to identify the behavior of their factors with that of any such units in the germ plasm as the older theories have assumed. Johannsen gives a name to the units of which his germ plasm is composed, the genes, but he defines genes and genotype strictly from the visible behavior of the different characters of the many-celled plant. The genotype is the specific germ plasm, each of the genes represents a unit character. How they are situated or related in the egg is unspecified, though it is suggested they probably have only a chemical constitution.

The Mendelian unit characters are, as noted, most typically generalized qualities of the plant or organ as physiological wholes. They are very diverse in their character and there is little attempt as yet to classify them. We have quantitative characters of weight and measure in fruits, stems, etc., superficial factors of color, which palpably depend on nothing more fundamental than a slight change in the degree of oxidation of a by-product of the protoplasm or a variation in the alkalinity or acidity of the cell sap.

We have factors for annual and biennial habit, as well as the more fundamental factors for form and tissue differentiation which are essential to the every-day existence of the organism. These heterogeneous

factors show couplings, repulsions, etc., without regard to any, at present, explainable relationship between them which would make it possible to associate them with any definite spatial distribution of *anlagen* in the germ cells.

It may be found to be one of the most valuable results of Mendelian experimentation that it has helped to destroy the last vestiges of preformationist ideas which inhered in the prearrangement of the hereditary corpuscles assumed in the theories of Weismann. It is certainly impossible to imagine where a corpuscle should be placed in the egg or what it should do to change a plant from an annual to a biennial, or a crenate to a serrate leaf.

It is sufficiently clear that the results of Mendelian and mutational breeding from the standpoint of the kind of unit factors observed and their behavior in cases of so-called coupling and repulsion are opposed to the doctrine of a spatially organized germ plasm made up of corpuscular units. The doctrine of the fixity of the unit characters and their segregation as pure elements seems still, however, to harmonize well with the conception of *pangens*, perhaps not so definitely related to each other, spatially, in the germ plasm. If there are fixed elements, unit characters, which are transmitted in reproduction, this is certainly strong ground for the assumption of the existence of corresponding corpuscular units in the germ plasm. The experience of experimental breeders with the doctrine of segregation must be examined critically as to the evidence it gives on this point. It is a fundamental assumption of Mendelism that the characteristics of the parents behave in fertilization, whether hybrid or normal, as unit characters, and that hybridization and the phenomena of segregation which follow give the best possible means of recognizing and identifying

them. Still there can be no question that the doctrine of segregation and alternative inheritance no longer has the clear and simple form in which Mendel proposed it. It is equally certain that the changes which have been made were necessary in order to bring the theory into harmony with the vast mass of new facts which breeding on a large scale has brought to light.

These modifications have largely been in the direction of providing for a greater degree of variability in the F_2 and succeeding generations than is provided for by the doctrine of segregation. Pre-Mendelian views held to a general breaking-up and tendency to vary in hybrids after the first generation. It was Mendel's great contribution to apparently discover in this multiplicity of forms a real simplicity in fundamental features. Recent workers have, however, found it increasingly difficult to interpret their results within the limits of the Mendelian formulæ.

One of the first steps in the modification of Mendel's views was to admit greater variation in the first generation. It is generally agreed now that there is no law of dominance, that the first generation may be intermediate, or a mosaic of the parental characters, and the possibility is present that there may even be di- or poly-morphism in the first generation. Practically all the pre-Mendelian conceptions as to the character of the first generation have now been confirmed and generally admitted.

An important step toward the modification of the Mendelian account of segregation in the second and following generations was in the introduction of the presence and absence hypothesis as a substitute for the Mendelian doctrine of pairs of positive visible characters. The presence and absence hypothesis when applied to simple Mendelian pairs of contrasting characters seems perhaps to have a sort of explana-

tory value. To be sure, the case is somewhat as if a geologist should explain a given hill as due to the absence of a mountain, failing to suggest anything as to the forces and conditions concerned in the production of both hills and mountains. There can be no question that Mendel's doctrine of segregation assumed the probable occurrence of alternative inheritance for all homologous differential qualities in the parents of hybrids. It was the task of the breeder to discover such pairs of opposite characters and operate with them. This has been found to be impossible in many cases, and the presence and absence hypothesis is advanced as an expression more nearly in accord with the facts as found in practical breeding work. The facts that have necessitated this change show that not all apparently homologous contrasting characteristics form allelomorphous pairs. When two contrasting flower colors are found not to form an allelomorphous pair, the pairing may sometimes still be discovered by operating with groups of characters in the formation of allelomorphs, such as pigmentation against white or albinism, and here again albinism is by no means always found to be the same thing in heredity.

In other cases the presence and absence hypothesis is introduced as a concession to the fact that the second and following hybrid generations are much more variable than the Mendelian doctrine allowed. On the Mendelian hypothesis of allelomorphous pairs and their segregation, two individuals differing in a single character, such as flower color, could produce but two kinds of gametes and four groups of offspring. On the presence and absence hypothesis we can assume at once four elements, a factor for the presence and absence of each of the two colors. To take the stock illustration: fowls with pea and rose combs when crossed

are found to produce two further new comb types, walnut in the F_1 and single in the F_2 generations. The whole result harmonizes with the assumption that we have here two allelomorphic pairs—rose present and absent and pea present and absent—the absence in each case resulting in single comb.

The real discovery here is that two birds visibly differing in the one feature of comb character do not produce monohybrid offspring, as in the case of the green and yellow peas, but show on breeding that the qualities pea and rose comb belong to separate allelomorphic pairs. This permits of four kinds of gametes and sixteen different combinations in the F_2 generation. That is, the result resembles that of a dihybrid rather than a monohybrid combination.

It is really a case of the assumption of two factors as responsible for a single unit character. And the use of the presence and absence hypothesis perhaps tends to obscure the real facts. Single comb is superficially at least just as positive a character as pea or rose comb. Single comb is found to occur in the absence of either pea or rose comb. If the absence had not happened to have the same result in both cases—if, for example, absence of pea comb had meant no comb, then the cross would have had a still different result. Stated in plain terms, the experiment shows that in applying Mendel's principles to a wider and wider range of experimental material we find it necessary to provide for a much greater degree of variability in our results than was anticipated. The pre-Mendelian dogma of the breaking-up of the F_2 generation is to this degree vindicated.

This adoption of the presence and absence hypothesis and of additional factors is probably an entirely correct method of procedure as far as it goes, and allows

much more fully for the real variability which we find in heredity.

That the increase of diversity with added pairs of differentiating characters in the parents should follow just this Mendelian law is, of course, only necessary on the assumption of fixed unit characters. It is a question whether it is sufficiently obvious that we need just twelve more groups in which to place our phenomena when we pass from the results of crossing parents with one visible difference to those with two visible differences. Perhaps some other number of groups would really classify the results of such a cross just as well as sixteen.

It is to be remembered that the biometrist dealing with symbols can proceed with perfect certainty that his results will be mathematically correct without troubling himself in the least as to whether his series of symbols corresponds to any realities. Handling a series of the combinations of numbers or letters from one to ten is very elementary mathematics, but to hold in mind and be able to visualize from day to day with certainty of a constant result ten related colors and their combinations in a bed of snap-dragons is, as can be shown by appropriate tests, a matter of expert training and considerable uncertainty. When we realize further that unit characters are not conceived as hard and fast categories, but as each having an allowed range of fluctuating variability, we can see that the chances of mistake in estimating the sixty-four classes of offspring which might come from a pair of parents differing in three characters are very great. It is a matter of difficulty for the student of the problem and it is almost impossible for any one who reads of such results to pass any critical judgment on their probable accuracy.

Formally the presence and absence

hypothesis is perhaps consistent with the corpuscular theories of heredity but the necessity of its introduction arising from the variability of the products of hybridization must be regarded as seriously affecting the basal conception of segregation of fixed unit characters.

Perhaps the most important modification of Mendelian theories is in the continuous discovery of further cases in which single visible characteristics as conceived by Mendel or De Vries may be dependent for their realization on from two to several factors, or may arise in more than one way. Nilsson-Ehle tells us that the black color in oats and the red color in certain wheats may each be produced in different ways. Shull finds that two separate genes may be responsible for the common form of capsule in *Capsella bursa-pastoris*. Bateson and Saunders tell us that certain white varieties of peas and stocks when crossed give purple. This is because the colors in question are due to two factors instead of one. These two factors are not members of one allelomorphic pair but must be assumed to be the members of two distinct pairs, each from different parents. Hoariness in stocks is dependent on four factors, two for hoariness and two for flower color, not compounded in one unit but distributed in four allelomorphic pairs. Reversion is the reappearance of a character because of the reunion of the two necessary factors which had become separated.

An extreme of this tendency is found in Tammes's recent paper on heredity in flax in which she has worked with three types and apparently has used all possible precautions as to control, etc. Tammes finds that the results of her study of seed size, petal size, petal color, etc., can only be brought into harmony with Mendelian ratios by assuming that each of these visible characters is dependent on from one

to several factors in the germ plasm. For the length of the seed at least four factors must be assumed. For length and breadth of petal three factors must be assumed in one cross and at least four in others. For flower color three factors were found; for dehiscence of seed pod three or four factors; for hoariness of seed pod alone one factor. Tammes finds in crossing two individuals differing in a single visible character where Mendel would expect to find a monohybrid giving four combinations in the F_2 generation that the results are those which should be expected in the case of a di- or poly-hybrid. In plain terms this merely states that the F_2 generation is, as the older views of hybridization held, vastly more variable than the ordinary Mendelian expectation permits.

It is probable that Tammes and the others who are assuming a multiplicity of factors as necessary to the production of a single visible character are giving the facts as they find them, but the doctrine of fixed unit characters represented by pangens or genes in the germ plasm certainly shows itself inadequate to account for such facts. These results attack the doctrine of the *pangen* at its very foundation. According to De Vries the multiplicity of plant and animal forms is due to the large number of combinations possible with relatively few unit characters. We are now given multiplicity in the germ plasm to account for apparent simplicity in the organism. On Johannsen's view also each factor must be represented by a gene in the germ plasm.

Furthermore, as noted, the unit characters are diffuse characteristics of the plant taken as a whole. Each hereditary factor responsible for this diffuse character may influence many parts of the plant. We have thus a most complex overlapping of functions among the factors, one char-

acter being dependent on several factors and each factor affecting a number of parts and even qualities of the plant.

Even the most thoroughgoing Mendelian must admit that a unit character made up of four fractions or assumed to be dependent for its realization on four factors has lost something of its unity. What the student of the germ plasm wants to know, of course, is the nature of these fractions or the ultimate elements in heredity, whatever they may be. The breeder may perhaps properly, as Baur does, relegate all questions as to the nature of the representation of the hereditary qualities of the many-celled organism in the egg to the future as outside the scope of his immediate experiments. The cytologist dealing directly with the germ plasm in the chromosomes is confronted directly with the question of their ultimate constitution and must attempt to connect any discoverable units in the make-up of the adult in some way with the structure and properties of the germ plasm itself. It is obvious that visible characters which may arise in more than one way or that require the combination of from two to several factors for their production can hardly be represented in the germ plasm by the *pangens*, determinants or other corpuscular units of the older theories. To call a visible character which depends on four hereditary factors for its production a unit character is certainly not conducive to clearness of thought. To attempt to find fixed units in the maze of fluctuating colors, forms and physiological processes of multicellular plants looked upon as wholes is perhaps a hopeless task. Much more is it inconceivable that such diffuse fluctuating characteristics are represented by specific corpuscles in the germ plasm.

We have noted that Mendelian breeding, emphasizing as it does the existence of

characteristics belonging to the organism as a whole and their couplings and repulsions in inheritance may have a most important result in the elimination of the last trace of the doctrine of preformation from our conceptions of the germ plasm. It seems to me also probable that the consistent study of the so-called unit characters is tending rapidly to the overthrow of all corpuscular theories of heredity, and that with a proper understanding and interpretation of the Mendelian factors we may finally be freed from these confusing molecular chemical analogies in the study of the germ plasm.

There are certain broad inconsistencies in the doctrine that the characters of the whole organism as such are represented in any fashion by units of the germ plasm, which should always be borne in mind. Most conspicuous of these is the fact that there is no proportion between either the number of the chromosomes or their mass and the complexity of the organism to which they belong. The simplest algæ and fungi may have as many chromosomes and, proportionally to the size of the cell and nucleus, as large chromosomes as some flowering plants. Allowing for a large amount of possible ultra-microscopic organization, such disproportions are not consistent with any corpuscular theory of heredity. It may well be that just as many of the so-called unit characters of Mendel and De Vries relate to the diffuse properties of the organism, as a whole, so the hereditary factors representing them depend on diffuse qualities of the cells as wholes in their interactions with each other. Such a view is not inconsistent with the doctrine that the chromosomes are the physical basis of heredity. We should perhaps, with Hertwig, more clearly distinguish between the heredity which determines the characters of the cells, epider-

mal, mesophyl, vessels, etc., and the determination of the qualities of the organisms as wholes which depend upon the interaction of these cells and which only indirectly represent and are represented by the organization of the cell and germ plasm. A leaf can not be represented directly in a cell, but the color of the leaf may be represented in the color of the cell, and its size may be determined by the capacity of the cell to divide and grow. Such Mendelian unit characters as color, length of life, etc., are properties of individual cells and agree with Detto's conception of metidentical characters which become by multiplication of the cells more or less diffuse properties of plants as wholes or organs as wholes.

It is easy to distinguish the heredity of the cell form as such from the heredity of the form of the many-celled colony. No one thinks now of asserting that the organization of the cell is identical with that of the many-celled individual. That dogma of the old preformationists disappeared with the improvement of the microscope. If we can, however, fix clearly in mind that such representation of the adult organism as is present in the egg in no way resembles in space configuration or in complexity the arrangement of organs and tissues in the adult animal or plant, we can attack the problem of form development as it really exists, and free from many encumbering traditions of preformation and epigenesis.

There can be no doubt that the cell and nucleus have a highly complex mechanical organization. It is a commonplace of histology that cell and tissue structures are relatively constant through genera and families—regardless of variation in the size and form of organs and of the plant as a whole. Cell size is also relatively constant through genera and even families.

Quantitative variations in the size of leaves, seeds, etc., are due to the number of cells they contain, and this, of course, depends on the number of times the cells have reproduced themselves by division. In some cases Mendelian characters can thus be identified with qualities of the cells.

The attempt from the standpoint of Mendelian conceptions of dominance and segregation to analyze the behavior of the generalized qualities of plants and their parts in development and heredity has been stimulating to research in a high degree, but the attempt to express the results of such analyses in terms of unit characters may be found to be only a relic of the preconceptions of the earlier corpuscular and preformational theories of heredity. Many Mendelians are inclined to think of their germ plasm as merely chemical in its essential constitution and I have referred above to the uncertainty of the evidence as to any ultramicroscopic organization of the nuclear chromatin of the cell. With the clarification of our conceptions in the domain of colloid chemistry we may hope to gain new viewpoints which will be more serviceable in the interpretation of biological facts than the conceptions of atoms and molecules which have so far dominated the corpuscular theories of protoplasmic structure. But we must also expect, perhaps, that the real distinctions between the organization of protoplasm with its long history of slow evolution and the *in vitro* aggregates of the chemist will be emphasized rather than obliterated.

R. A. HARPER

COLUMBIA UNIVERSITY

SCIENTIFIC NOTES AND NEWS

DR. FRANZ BOAS, professor of anthropology at Columbia University, has been given the doctorate of science by Oxford University.

THE Stevens Institute has conferred its doctorate of engineering on Professor Charles F. Scott, who holds the chair of electrical engineering in the Sheffield Scientific School of Yale University.

THE University of Manila has conferred a doctorate of science on Father José Algué, director of the Weather Bureau.

AMONG the degrees conferred by Columbia University, at its recent commencement, was the doctorate of letters on Dr. John Grier Hibben, president of Princeton University; the doctorate of science on Colonel George W. Goethals, chief engineer of the Panama Canal, and the degree of master of science on Dr. S. S. Wheeler, president of the Crocker-Wheeler Company.

KING GEORGE has conferred a knighthood on Mr. Harry James Veitch, distinguished for his work in horticulture.

THE board of trustees of the University of Alabama at their meeting on May 30, 1912, relieved Dr. Eugene A. Smith, professor of mineralogy and geology, of active class-room work, in order that he might devote his whole time to the Geological Survey and to the up-building of the museum of Smith Hall, the new building named in his honor and devoted to geology and natural history. Dr. Smith is retained in the university as head of the department of geology and as director of the museum. The teaching is turned over to Dr. Wm. F. Prouty, professor of geology, and his assistants. This action of the board of trustees was based on the request of Dr. Smith and the recommendation of President Denny.

MR. OLIVER B. HOPKINS, who recently received his Ph.D. degree at Johns Hopkins University, has been appointed assistant state geologist of Georgia to fill the position made vacant by the resignation of Dr. T. Poole Maynard.

T. R. ARKELL, associate professor of animal husbandry at the New Hampshire College, has resigned to accept a position with the Canadian government as head of the sheep division in Ottawa.

PAUL RADIN, Ph.D. (Columbia, '11), has been appointed to the fellowship of the International School of American Ethnology and Archeology for research in anthropology in Mexico City.

DR. WILLIAM H. HALE, superintendent of public baths in Brooklyn, has been appointed to represent New York City at the International Public Bath Conference to be held in Holland from August 27 to 30.

DR. BURT G. WILDER, professor emeritus in Cornell University, lectured recently at the Charleston Museum. He spoke on the silk spider, and at the conclusion of his lecture took occasion to highly compliment the work of Dr. P. M. Rea, director of the museum.

DR. ARTHUR W. GOODSPEED, professor of physics in the University of Pennsylvania, will on June 13 give the commencement address at the South Carolina Military College, Charleston.

PROFESSOR HUGO MÜNSTERBERG, who has now sailed for Europe, gave an address on June 4 before the Naval War College in Newport, R. I., on "The Psychology of the Navy," and an address on June 5 before the American Association for Labor Legislation on "The Psychology of Industrial Efficiency."

PROFESSOR D'ARCY W. THOMPSON, professor of natural history at Dundee, has been appointed Herbert Spencer lecturer at Oxford for 1912.

At a meeting of the Chemical Society at Burlington House on June 26, Sir William Tilden, F.R.S., will deliver a memorial lecture in honor of the late Professor Stanislaw Cannizzaro.

DR. ED. STRASBURGER, the eminent botanist, professor at Bonn, died on May 20, aged sixty-eight years.

DR. ALFRED PRIBRAM, professor of pathology in the German university at Prague, has died, aged seventy-one years.

THE U. S. Civil Service Commission announces an examination on June 29 to fill vacancies in the position of agriculturist at salaries ranging from \$2,000 to \$2,500, and as-

sistant agriculturist at salaries ranging from \$1,600 to \$1,800 a year, Office of Farm Management, Bureau of Plant Industry, Department of Agriculture.

FOLLOWING a meeting of the biological section of the Kansas State Teachers Association a committee has been appointed to study the teaching of biology in the high schools of the state. The members of the committee are: H. F. Roberts, *chairman*, Kansas Agricultural College, botany; I. D. Cardiff, Washburn College, botany; W. C. Stevens, Kansas State University, botany; C. E. McClung, Kansas State University, zoology; J. W. Scott, Kansas Agricultural College, zoology; O. P. Delinger, Manual Training Normal School, biology; L. C. Wooster, Kansas State Normal School, biology; Wyman Greene, Wichita High School, zoology; W. E. Ringle, Cherryvale High School, botany and zoology; E. J. Dumond, Garden City High School, principal of high school.

THE University Commission on Southern Race Questions was recently organized at Nashville, Tenn. It consists of 11 members, each a representative of a southern state university. Professor C. H. Brough, of the University of Arkansas, was elected president and Professor William M. Hunley, of the University of Virginia, secretary. The next meeting will be held on December 19 at the University of Georgia, Athens, Ga. The chief object of the commission is to study the negro in his relation to southern life. The commission was organized through the efforts of Dr. James H. Dillard, president of the Jeans fund and director of the Slater fund, of New Orleans.

MR. PETER A. B. WIDENER, of Philadelphia, has set aside a fund of four million dollars for an endowment for the Widener Home for Crippled Children, which he had previously established with three million dollars. The present gift is in memory of his son, Mr. George D. Widener, who perished on the *Titanic*. His grandson Mr. Harry Elkins Widener, who also perished on the *Titanic*, has bequeathed his valuable library to Harvard University, and the family will erect a wing to the library building to house it.

THE Sleeping Sickness Bureau under the British government will hereafter be known as the Tropical Diseases Bureau. The new bureau will deal with all exotic diseases which are prevalent in tropical and subtropical regions, and will publish at frequent intervals a *Tropical Diseases Bulletin*, which will take the place of the present *Sleeping Sickness Bulletin*. As the British Medical Journal states, the Sleeping Sickness Bureau had its origin in the International Conference on Sleeping Sickness held in London, under the presidency of Lord Fitzmaurice, in June, 1907, and March, 1908, to concert measures for the control of that disease, which was spreading rapidly in tropical Africa. It was then proposed to have a central international bureau "to extract and circulate all new literature on sleeping sickness." This project fell through, because the delegates were not unanimous as to the seat of the bureau, or even the necessity for its separate existence. Arrangements were therefore made by Lord Elgin, then colonial secretary, for the establishment of a British Bureau, maintained by imperial funds, with a contribution from the Sudan government. The bureau, having outgrown the accommodation provided by the Royal Society, will have its quarters at the Imperial Institute.

UNIVERSITY AND EDUCATIONAL NEWS

LORD IVEAGH has given £10,000 to the University of Dublin, as an endowment fund for the department of geology and mineralogy.

THE University of Cincinnati held its thirty-fourth annual commencement exercises on June 4. A feature of the ceremonies was the official presentation to the university of the new engineering building, power plant and gymnasium and the Carson athletic field.

THE Harper Memorial Library of the University of Chicago was dedicated on June 11. The leading events of the services were a historical statement by President Harry Pratt Judson; a memorial address by Dean Albion W. Small, head of the department of sociology;

an address on behalf of the alumni by Mr. Donald R. Richberg, '01; a poem by Professor Edwin H. Lewis, Ph.D., '94; an address by Henry E. Legler, librarian of the Chicago Public Library; an address by Mr. Charles A. Coolidge, of the firm of Shepley, Rutan & Coolidge, architects of the building, and an address by James B. Angell, president emeritus of the University of Michigan. Mr. Franklin MacVeagh, secretary of the treasury, will deliver the address at the Convocation, which will be held in Harper Court at 3 P.M.

THE main building of the Agricultural and Mechanical College of Texas was destroyed by fire on May 27, between the hours of two and four in the morning. This building was erected in 1876 at a cost of \$100,000. It contained the administration offices, the library and class rooms for three departments.

A DORMITORY consisting of two, three, four and five-room apartments for married students has been established at the University of Chicago.

DR. FREDERICK J. E. WOODBRIDGE, professor of philosophy, has been appointed dean of the graduate faculties of Columbia University.

At the Massachusetts Institute of Technology the William Barton Rogers professorship of economic geology has been established as a memorial to the founder of the institute, and with a portion of the bequest of Mrs. Rogers. Mr. Waldemar Lindgren, chief geologist of the U. S. Geological Survey, has been elected to this chair. In the same department Dr. Charles H. Warren has been advanced to be full professor and Dr. Frederick H. Lahee, of Dartmouth College, and Mr. John D. Mackenzie, of Cornell University, have been called as instructors. Professor T. A. Jaggar, Jr., as has already been noted in *SCIENCE*, will spend about five years as director of the Hawaiian Volcano Observatory. Promotions at the institute have been made as follows: To full professorships: F. J. Moore, organic chemistry; C. L. Adams, drawing and descriptive geometry; O. E. Fuller, theoretical and applied mechanics; C. F. Park, of mechanism, and W. A. Johnson, theoretical and applied

mechanism. To associate professorships: W. K. Lewis, chemical engineering; C. W. Berry, heat engineering; H. W. Hayward, theoretical and applied mechanics, and C. J. Riley, heat engineering. To assistant professor: R. P. Bigelow, zoology and parasitology; H. K. Burrisson, mechanical drawing and descriptive geometry; W. H. James, mechanical drawing; L. S. Smith, theoretical and applied mechanics; C. R. Hayward, mining engineering and metallurgy, and N. C. Page, physics. Research associate Charles A. Kraus has been made assistant professor of physico-chemical research; assistant J. P. Maxfield instructor in physics and assistant Franz Schneider, Jr., instructor in biology and public health.

STEPHEN S. COLVIN, Ph.B. (Brown, '91), Ph.D. (Strasburg, '97), professor of psychology in the University of Illinois, has accepted a chair in educational psychology in Brown University, newly established in cooperation with the State Board of Education with the assistance of an appropriation made by the state legislature.

DR. A. S. PEARSE will succeed Professor S. J. Holmes in the zoological department of the University of Wisconsin.

New instructors in the department of anatomy of the University of Pittsburgh Medical School are announced as follows: Edgar Davidson Congdon, A.B., A.M. (Syracuse), Ph.D. (Harvard), instructor in anatomy in the Cornell Medical School, New York City, N. Y., and Otto Frederick Kampmeier, A.B. (Iowa), Ph.D. (Princeton), fellow in comparative anatomy at Princeton.

DR. BERTRAM G. SMITH, during the past year a graduate student in Columbia University, has been appointed assistant professor of zoology in the Michigan State Normal College at Ypsilanti.

MR. C. M. HILLIARD, who has been teaching bacteriology for two years at the College of the City of New York, has resigned to accept a position as assistant professor of bacteriology and sanitary science at Purdue University. Mr. Hilliard's place at the City College will be taken by Dr. W. W. Browne, who takes

his doctor's degree with Professor Gorham at Brown University this spring.

DR. O. D. VON ENGELN has been promoted to an assistant professorship of geography at Cornell University.

DR. GRAHAM EDGAR has been promoted to be associate professor of chemistry at the University of Virginia.

PROFESSOR J. L. GILLIN, of the State University of Iowa, who has been teaching sociology there for the past five years, has accepted a call to the University of Wisconsin, service to begin with the opening of the next school year. The work of Professor Gillin at the University of Wisconsin will be to teach courses in sociology during one semester of the year and the remainder of his time will be spent as secretary of the department of general information and welfare, one of the four departments in the extension division of the university.

MR. M. POWER, lecturer in mathematics at Dublin, has been appointed professor of mathematics at Galway.

PROFESSOR F. G. DONNAN, Muspratt professor of physical chemistry at Liverpool, has declined the chair of chemistry at University College, London, vacant by the retirement of Sir William Ramsay, K.C.B.

DISCUSSION AND CORRESPONDENCE

THE NATURE OF THE INHERITANCE OF HORNS IN SHEEP

To our communication in *SCIENCE* of March 8 Professor Castle has offered¹ a vigorous critique. A wordy continuation of the discussion of a matter most of whose points can be easily settled by experiments now under way would be to imitate the methods of an old continent and a past epoch in biology. We may add only that the simple Batesonian formula which Dr. Castle seems to find sufficient appears from the context no more fully satisfactory to the formulator than to ourselves. As to the effect of castration in eliminating horns in males, this is, apparently, a special result in Merinos and other races

possessing horns typically or prevailingly in the males only. Darwin has discussed this matter in the "Descent of Man," Chap. XVII.; and correspondence recently had with breeders of Merinos confirms Darwin's (and Castle's) statements. In Dorset Horns, on the other hand, as in reindeer and cattle, castration has only a modifying effect.

Finally, we wish to acknowledge kind suggestions (in letters) from Professor T. H. Morgan and Mr. A. H. Sturtevant, and we trust they will publish their formula, which differs in several respects from ours. The principal difficulty they find with our formula is that it does not account for a race in which, in successive generations, all males are horned and all females are hornless. Such a race of Merinos there may be; but there is much evidence that in many long and carefully bred strains of Merinos the standard of hornlessness in the ewes is maintained only by hurrying the horned ewe lambs to the butcher.

T. R. ARKELL

C. B. DAVENPORT

May 8, 1912

AGRICULTURE IN SCHOOLS

TO THE EDITOR OF *SCIENCE*: I note in the issue of *SCIENCE* dated April 27, 1912, an announcement concerning the signing of the Harte bill providing for the establishment of a New York State School of Agriculture on Long Island. The memorandum by the governor appended to this bill, as quoted in *SCIENCE*, might mislead the reader in regard to the status of the teaching of agriculture in New York.

The Cortland State Normal School has had in operation for nearly a year a course for training teachers of agriculture. This course is open only to graduates of approved high schools who have had practical farm experience. The course is for two years' work. It may be that the fact that the governor has not been called upon to sign a bill of special appropriation for the establishment of this course has been the cause of his overlooking it.

In regard to the high school situation I wish to call attention to the fact that seven-

¹ *SCIENCE*, April 12.

teen schools have a full four-year high-school course in agriculture and will therefore receive \$500 each in accordance with Article 22, Education Law of 1910. In addition to these special vocational courses in established high schools twenty-three high schools give some instruction in agriculture.

L. S. HAWKINS

CORTLAND, N. Y.

SCIENTIFIC BOOKS

The Absorption Spectra of Solutions of Comparatively Rare Salts Including those of Gadolinium, Dysprosium and Samarium, the Spectrophotography of Certain Chemical Reactions and the Effect of High Temperature on the Absorption Spectra of Non-aqueous Solutions. By HARRY C. JONES and W. W. STRONG. Publication No. 160 of the Carnegie Institution of Washington.

In this monograph the authors present the results of their recent spectrochemical investigations carried out along the three following distinct lines: (1) The mapping of the absorption spectra of certain comparatively rare substances, (2) the spectrophotography of some oxidation reactions, and (3) the effect of relatively high temperatures on the absorption spectra of alcoholic solutions.

In an introductory chapter a brief review is given of some important spectrochemical investigations of the last decade concerning the nature of the emission and absorption centers of light; the connection between these centers and molecular and atomic structures; the effect of ionization and recombination on these centers, and the effects that can be produced by physical and chemical agents upon the constitution of the emission and absorption centers.

The general method of experiment was similar to that employed by Jones and his co-workers in their previous investigations. For experiments at high temperatures a new form of absorption cell was devised, for a description of which the original monograph must be consulted. Through the kindness of Professor Urbain sufficient quantities of the oxides of samarium, dysprosium and gado-

linium were loaned the authors to enable them to prepare the various salts whose solutions they wished to study.

An examination of the spectrograms in this and the preceding monographs shows that in general the absorption spectra of various salts of the same element are very similar. With high dispersion the minute structure of the bands and groups of bands is shown to be very different for different salts of the same element, this being especially true of the salts of neodymium. Beers's law has been shown to hold approximately for nearly all solutions of a single neutral salt in a single solvent. Each solvent is characterized by a definite absorption spectrum, and when a salt is dissolved in a mixture of varying proportions of two solvents only two definite absorption spectra appear, a result which the authors interpret as an indication of the formation of definite compounds of solvent and solute or "solvates."

In their study of oxidation phenomena uranous salts were subjected to the action of both weak and strong oxidizing agents, the salts being dissolved in single and mixed solvents. On dissolving uranous chloride in a mixture of alcohol and water, the bands characteristic of both solvents appear simultaneously. A mild oxidizing agent was found to oxidize the "hydrated" salts and leave the "alcoholated" salts unchanged, while with a strong oxidizing agent both "hydrated" and "alcoholated" salts were oxidized to the uranyl condition.

Rise of temperature has been shown to cause a widening of the bands in solutions of a pure salt in a single solvent, the edges of the bands becoming hazy. When several salts are dissolved in the same solvent the bands become weaker as the temperature rises. In general the center of intensity of the single bands remains unaltered with rise in temperature.

This recent publication of Jones and his associates is another valuable contribution to the literature of spectrochemistry and will undoubtedly find a place on the book-shelves of those engaged in spectroscopic investigations. No little credit is due the printer for the ex-

cellence of his work, without which the plates would be of much less value.

FREDERICK H. GETMAN

Historical Papers on Modern Explosives.

By GEORGE W. MACDONALD. Whittaker & Co., N. Y. 1912. Pp. 192. \$2.50 net.

When the age of the world as fixed by the most recent observers, such as Becker and Clarke, the probable length of time it has been inhabited by man, and the important part which chemistry played, both in the creation of the earth and of its inhabitants, is considered, it is an amazing thing that man was so very slow in assembling a systematized knowledge of chemistry and especially slow in recognizing those compounds which are reservoirs of energy, for though compounds of this kind, such as the nitrosubstitution compound, picric acid, discovered by Hausmann in 1788, were described in the latter part of the eighteenth century, it was not until the opening year of the nineteenth century, in which Howard discovered mercuric fulminate and demonstrated its properties, that man apparently began to realize that energy could be stored up in individual compound molecules which was ready for release at command, so that it might be employed like the bent bow, the coiled spring, the head of water, the wind, or the energy of man or animals applied through the many mechanical devices then invented, or mixtures of substances, such as gunpowders, to do work.

This new conception of a capacity with which compound molecules might be endowed was, in the middle of the nineteenth century, reinforced by Schönbein's discovery of cellulose nitrates and Sobrero's discovery of glyceryl nitrates; and the discovery and recognition of the value of molecules so constituted to mankind in the accomplishment of work has gone on with continued acceleration ever since, for masses of the mercuric fulminate, cellulose nitrates, glyceryl nitrates, alone or compounded into mixtures such as the many dynamites, smokeless powders and permissible explosives, have been put to do work in engineering projects and in military operations,

and they have, when wisely used, materially increased the resources of man in his contest with the material world in which he is placed and envired.

The period covered by MacDonald in the book under review is from 1800 to 1887 and it deals with the discovery and development of the three explosives last enumerated. This was a period of marked scientific and technical activity with regards to these bodies and much was published regarding them in widely scattered publications, some of which are now difficult of access, and because of this, and further because the earliest literature "often contains observations and experiments which are generally considered to be the results of much later investigation" the author has brought them together here after having published them as separate articles in *Arms and Explosives*.

Mr. MacDonald has not given reprints but rather condensed résumés in which he has divided single articles into several smaller ones and introduced comments of his own. Further he has drawn his material from patent literature and unpublished correspondence as well as from scientific journals, and recast or "reduced tabulated results to statements of fact." It will be seen therefore that the book is not authoritative, even to the extent that carefully supervised reprints would be, and that its usefulness is limited.

There appears a lack of proportion in the treatment since 149 out of the 192 pages are devoted to gun cotton and 98 of these to Abel's work leaving Schönbein the discoverer, and von Lenk, whose pioneer work in Austria was presented freely and in detail to the Committee of the British Association, quite in the background. In fact there is a distinctly British tendency permeating the book.

CHARLES E. MUNROE

Insect Pests of the Farm, Garden and Orchard. By E. DWIGHT SANDERSON. New York, John Wiley & Sons. 1912. \$3.00.

The author explains in the preface how his attempt to revise his former book "Insects Injurious to Staple Crops" finally resulted in

extending its scope and practically rewriting it, until the present volume came out of it. Entomologists, orchardists, farmers and teachers are all indebted to Professor Sanderson for bringing together the scattered up-to-date information presented in this book. Many control methods and remedies recommended in previous works have recently been superseded and are therefore out of date.

The subject matter of the volume in question is well presented, and the illustrations for the most part are satisfactory, though one questions if it is not better to use photographs entirely of spraying apparatus rather than the trade cuts from manufacturers' catalogues. Some other ancient cuts have also been used which do not add to the usefulness or attractiveness of the volume. Most of the illustrations are excellent, a goodly number are original, and many have appeared before in entomological journals and experiment station bulletins, due credit being given. It is perhaps impossible to prepare and print a work of this magnitude without finding some errors in it, but the errors in this volume are mostly typographical, and can easily be corrected in future editions. A few of the illustrations are badly printed, but in most respects the mechanical production of the book leaves nothing to be desired.

The work should supply a distinct need, and ought to be placed on the shelves of all libraries.

W. E. BRITTON

TERMS USED TO DENOTE THE ABUNDANCE OR RARITY OF BIRDS

WHEN reading lists of birds, which indicate their abundance or rarity, it is often very difficult to tell just how common or how rare a bird is, for it is seldom that any two people use the same scale of terms. In fact few have any definitely graded scale, most preferring to write them as they are needed, and consequently, without realizing, they have a long illogical list of terms. Those most frequently adopted are given below. I have limited myself to eight, which are: abundant, common, frequent, uncommon, occasional, rare, scarce

and irregular. Together with other terms that are used I have given my reasons for not using them. Those which I have selected have been proposed chiefly, and all agreed to by Mr. C. William Beebe.

Abundant.

Very Common is the same as Abundant, for Abundant means More Common than Common.

Common.

Plentiful means the same as Abundant or Common.

Usually Common or Usually Rare are the same as Common or Rare, for we are writing about what the bird usually is, so Usually may be omitted.

Quite Common. The real meaning of Quite is "completely" or "wholly." It is wrongly used to indicate "to a considerable extent." Thus Quite Common, correctly used, means no more than Completely Common, or simply Common.

Not Uncommon is equal to Common.

Tolerably Common is usually used to mean Fairly Common, but thus used it is a very meaningless word, as tolerably means that which can be endured. If one wishes to use it as meaning Fairly Common, he can just as well use the latter word or, instead of these, Frequent.

Frequent.

Often Seen is the same as Frequent.

Usually Tolerably Common is the same as Tolerably Common, which is the same as Frequent. Fairly Plentiful is the same as Fairly Common. Fairly Common is the same as Frequent.

Uncommon.

Infrequent is the same as Uncommon or Occasional.

Not Common is Uncommon.

Occasional.

Sometimes Seen is Occasional.

Accidental is Occasional or Rare.

Rare.

Very Rare is using an unnecessary adverb, for Rare is Very Rare, and to use the latter, only makes a list more confusing and difficult to understand.

Scarce.

Scarce does not mean the same as Rare, but indicates that the bird mentioned was at some previous time Common, but that it has since decreased in numbers until it is now Rare.

Very Scarce means Scarce (Very is unnecessary).

Irregular.

Irregular indicates that at times the bird may be Common and at other times Rare. Often this has to be used in connection with one of the other seven terms. In such cases it is often necessary to add Usually; as: Cross-bill, Irregular, Usually Rare.

Of course it is not intended that these terms should always be used by themselves. One may use them, when necessary, in conjunction with other words; as, Common Migrant, Scarce Resident, etc.

JOHN DRYDEN KUSER

BERNARDSVILLE, N. J.

TRIVALENT PLATINUM

THE first evidences of the existence of compounds in which platinum acts with a valence of three were found about two years ago by Wöhler. On carefully chlorinating PtCl_2 , or dechlorinating PtCl_4 at 390° , a greenish-black powder was formed which had the formula PtCl_3 . This dissolved slightly in cold water, but more rapidly in hot, with the formation of an acid, H_2PtCl_6 , some hydrolysis also taking place. By precipitating with soda, a pure hydrated sesquioxid was obtained, but this could not be dehydrated without decomposition. When the hydrate was dissolved in acid a mixture of chloroplatinous and chloroplatinic acids was formed. Wöhler found, however, that when a dilute solution of cesium and a mixture of chloroplatinous and chloroplatinic acids was mixed with chlorine water, a dark-green powder is precipitated, of the composition Cs_2PtCl_6 , which has a strong tendency to decompose into the chloroplatinite and chloroplatinate.

This work has been strikingly confirmed in a paper read by Levy before the Chemical Society (London) on March 25. Levy was working on the copper-red iridescent salt, discovered by Hadow, which is formed when chlorin or bromin is added to a solution of potassium cyanoplatinite. To this Hadow gave the composition of $5K_2Pt(CN)_4 \cdot K_2Pt(CN)_4 \cdot Br_2$. The character of the salt Levy confirmed, but its formula should be $6K_2Pt(CN)_4 \cdot K_2Pt(CN)_4 \cdot Br_2$. Levy also found that when the cyano-

platinate is oxidized by lead or manganese dioxide in the presence of sulfuric acid, a similar compound is formed, but containing SO_4 instead of Br_2 , which behaves like the sulfate of a feebly electropositive element; in other words the group $(7\text{K.Pt}(\text{CN})_6)$ acts like a bivalent positive ion. More interesting was the result when hydrogen peroxid and other peroxids were used as the oxidizing agents. With the potassium cyanoplatinate there is at once formed a well-defined, crystallized double salt of the composition $3\text{K}_2\text{Pt}(\text{CN})_6 \cdot \text{KPt}(\text{CN})_6 \cdot 6\text{H}_2\text{O}$, which is not further acted on by hydrogen peroxid. When, however, perhydrol is used the oxidation to $\text{KPt}(\text{CN})_6$ is complete, and a series of similar salts was prepared. With the free cyanoplatinous acid, $\text{H}_2\text{Pt}(\text{CN})_6$, the oxidation to $\text{HPt}(\text{CN})_6$ by hydrogen peroxid is complete. Here we have an acid and its salts in which the platinum acts, as in Wöhler's halid salts, as trivalent, and its formula may be written $\text{HCN} \cdot \text{Pt}(\text{CN})_5$. These cyanoplatinates would bear the same relation to the cyanoplatinates as the ferrocyanids bear to the ferricyanids. This is unexpected, as it would naturally be inferred that in accordance with the analogy furnished by the haloplatinates and haloplatinates, the cyanoplatinates would have the formula $\text{M.Pt}(\text{CN})_6$. No evidence was found of similar compounds of the type $2\text{MCN} \cdot \text{Pt}(\text{CN})_6$ or $3\text{MCN} \cdot \text{Pt}(\text{CN})_6$. On treatment with KCN or with any alkali, decomposition ensued, with the regeneration of the cyanoplatinate.

J. L. H.

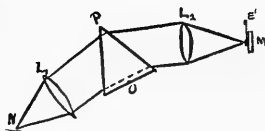
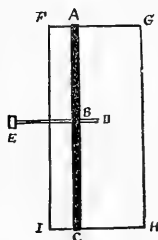
SPECIAL ARTICLES

SIMPLE DEMONSTRATION APPARATUS FOR THE INFRA-RED SPECTRUM

Most teachers of experimental physics in this country do not attempt to illustrate the optical properties of matter in the long wavelength invisible spectrum, for the reason that the standard detecting instruments, the bolometer, thermopile, radiometer or radiomicrometer, are not particularly well suited for use in the lecture room where great stability is not usually ensured. Moreover, unless the lec-

turer in general physics happens to have had considerable experience in the use of these instruments they are likely to cause annoying delays in the generally hurried preparation for an experimental lecture.

For demonstrative purposes the simpler an instrument is the better, provided it may be made sufficiently sensitive, because in an elementary lecture course there is danger of the student losing sight of the very phenomenon which an instrument is designed to render apparent if his attention is divided between the instrument and the phenomenon. I have recently devised a substitute for the



bolometer or other detecting instrument which meets the requirement of simplicity in an eminent degree, as it consists only of an india-rubber band, a glass fiber, a small mirror and a small piece of plate glass. It may be put together and adjusted in less than a minute and may be mounted anywhere on the lecture table, as it does not require a very stable support.

It is well known that the elasticity of

stretched india-rubber increases with increasing temperature so that on heating the stretched piece it shortens. An india-rubber band about one millimeter wide is stretched to nearly double its length about the rectangular frame of plate glass $FGHI$ and a glass staff DE (which should be as straight as possible and of a diameter such that it is just stiff enough to support the small mirror E of silvered microscope cover-glass of about two or three square millimeters area) is placed, as shown in the figure, under the rubber band at its middle point B . If the portion AB be heated the staff DE will roll on the frame towards the edge FG , and a beam of light reflected from the mirror E may be used to indicate (and magnify) this contraction of the india-rubber band. A change of temperature of both portions of the band, AB and BC , will be without effect on the position of the mirror E . This ensures steadiness of "zero." The inertia of the moving parts is small and the change in elasticity of the rubber follows the changes of temperature without any very noticeable lag, so that the instrument is both "dead beat" and sufficiently quick to respond to *differences* in temperature between the sections AB and BC , and insensitive to changes in temperature which affect *both* of the sections.

For use as a substitute for the bolometer it is sufficient to clamp the rectangle $FGHI$ in a vertical plane and to cause the spectrum to pass across the portion AB —the rise in temperature of the strip AB is approximately proportional to the energy present in the portion of the spectrum which covers AB and, the change in elasticity being approximately proportional to the change in temperature, the deviation in the beam of light from the mirror is approximately proportional to the energy present in the particular part of the spectrum which covers the strip.

For demonstration in the spectral region between the red and wave-length $\lambda = 3\mu$ where glass begins to be opaque the arrangement shown in the figure is convenient— N is a Nernst filament mounted in a vertical plane V — h_1 and h_2 large short-focus glass lenses and

P a large glass prism (a 60° prism 3 inches high and 4 inches on the slant face works well, though one half this size would do, particularly if very short-focus lenses were used). *M* is the plate glass rectangle *FGHI* mounted vertically at the principal focus of the lens *h*₂, so that the colored images of the Nernst filament are parallel to the band *AB*.

It is well to mount the prism so that it may be gradually rotated about the vertical axis through *O*. If large lenses and a large prism are available it is well to use the long 220-volt Nernst filament and to choose the rubber band so that the length *AB* is about equal to the length of the Nernst glower used.

As the prism is rotated and the spectrum moves across the band the deviation of the beam of light from the mirror *E* increases and reaches a maximum and it is easy for the audience to see that this maximum is reached when no visible light is falling on the band *AB*.

By setting the prism so that the red of the spectrum falls on the band, and noting the change in the deviation of the beam of light from the mirror *E* as various substances are placed in front of the Nernst glower, and then noting the changes produced by the same substances when they are introduced under the condition that invisible long wave-length energy falls on the band, it can be readily shown that not all substances which are transparent are diathermanous.

AUGUSTUS TROWBRIDGE

PRINCETON UNIVERSITY

THE AMERICAN SOCIETY OF ZOOLOGISTS

THE Central Branch of the American Society of Zoologists met at the University of Illinois, Urbana, Ill., April 5 and 6, 1912.

The following officers of this branch were elected for the ensuing year:

President—H. B. Ward, University of Illinois, Urbana, Ill.

Vice-president—C. M. Child, University of Chicago, Chicago, Ill.

Secretary-treasurer—W. C. Curtis, University of Missouri, Columbia, Mo.

Additional Members of the Executive Committee—C. E. McClung, University of Kansas, Lawrence,

Kans. (for three years); H. F. Nachtrieb, University of Minnesota, Minneapolis, Minn. (for two years).

At the business meetings, on April 5, action was taken as follows:

Resolutions upon the death of Professor C. O. Whitman as spread upon the minutes of the society were read.

By vote of the society the committee on the form of presenting papers for publication, Dr. C. E. McClung, chairman, was continued. No report was made.

The following report of the committee on nomenclature, Professor C. C. Nutting, chairman, was read and unanimously adopted:

The Committee on Nomenclature appointed at the Iowa City meeting of the Central Branch of the American Society of Zoologists reported last year a plan whereby various zoological organizations in America might unite in an effort to influence the International Commission on Nomenclature in the direction of securing greater flexibility in the interpretation of the rules. The committee begs to report that after extended correspondence it has reached the unanimous conclusion that it is impossible to secure any modification of the present practise through the International Commission itself, and that the officers of that commission maintain that its hands have been tied through action recently taken by the International Congress. It appears consequently that recourse to the International Congress itself offers the only remedy for the adjustment of the difficulties. That these are increasingly apparent becomes evident by the protests and appeals which are finding expression in various form from individuals, from groups of workers and from societies not only in this country, but in various other parts of the world, as a result of which several propositions have already been formulated for presentation to the meeting of the International Congress at Monaco in August, 1913.

The Committee on Nomenclature reports to the American Society of Zoologists, Central Branch, requesting at this time:

1. Authority to ask from the membership of the Central Branch an expression of opinion on the following question: Do you favor the strict (inflexible) application of the priority rule as the latter is now interpreted by the International Commission on Nomenclature?

2. The adoption of the following resolution for transmission to the International Zoological Con-

gress at Monaco in 1913: All propositions for amendments to rules on nomenclature which are approved by a majority of the International Commission on Nomenclature shall be submitted to the International Congress for final decision by vote in open meeting. In case it appears that any legislation to the contrary has been adopted by a previous International Congress, the International Congress at Monaco is respectfully urged to reconsider and repeal such action.

Signed, S. W. WILLISTON
H. B. WARD
C. C. NUTTING (chairman)

The treasurer of the society was authorized to allow the committee on nomenclature funds sufficient to obtain a census of opinion regarding the question of priority in nomenclature.

Professors Lillie, Lefevre and Patterson were appointed a committee to draw up resolutions upon the death of Professor Montgomery.

The following papers were presented at the meeting, either in full or by title:

Fertilizing Power of Portions of the Spermatozoon: FRANK R. LILLIE, University of Chicago.
(Published in SCIENCE, March 22, as part of the report of the proceedings of the Eastern Branch.)

On the Presence of Independent Mesenchymal Lymph Spaces in Turtle Embryos as Determined by the Study of Injections and Sections: FRANK A. STROMSTEN, University of Iowa.

The results set forth in this paper were based on the study of embryos of the loggerhead turtle. The blood-vascular system had been injected through the vitelline vessels. The lymphatics were injected through the jugular lymph-sacs, using the methods of Knower and Sabin. Serial sections of these embryos show that the peri-aortic lymph plexus is always preceded by a series of independent spaces which can neither be injected from the lymphatic nor the blood-vascular systems. Proofs, based on a series of photomicrographs and wax reconstructions, were given to show that these independent spaces are derived directly from the original intercellular mesenchymal spaces, and that they finally become part and parcel of the lymphatic plexus.

- (1) *A Curious Reproductive Habit among Water-bugs.*
- (2) *Asymmetry in Coricidæ with an Hypothesis as to its Possible Significance.*
- (3) *The Reactions of Fiddler Crabs to Various Solutions with Especial Reference to the Problem of Permeability and the Theory of Bal-*

anced Solutions: J. F. ABBOTT, Washington University.

More Trouble for the Systematist: C. C. NUTTING, University of Iowa.

Note on the Embryonic Development of the External and Internal Carotids of the Chick: WM. A. LOCY, Northwestern University.

The Morphology of the Sympathetic Neurones in the Myenteric and Submucous Plexuses: ALBERT KUNTZ, University of Iowa.

In the myenteric and the submucous plexus in the small intestine of the cat and the dog sympathetic neurones of several distinct types may be observed. The two types which are most evident may be characterized as follows: (a) neurones which are irregular and more or less angular in outline possessing numerous varicose dendrites which vary greatly in length and in diameter and usually show numerous short branches; (b) neurones which are more regular in outline, possessing fewer dendrites which are usually long and slender and show only few branches. Neurones of both these types are present in considerable numbers in the myenteric plexus. In the submucous plexus the neurones of the second type preponderate.

The ganglia of these plexuses are variously connected by commissures in which may be traced both axones and dendrites. Fibrous commissures also connect the two plexuses with each other, while from the submucous plexus fibers may be traced into the plexuses surrounding the digestive glands and into the intestinal villi, where many of them, doubtless, terminate on cells of the digestive epithelium. Such terminations could frequently be observed, but in no case could an individual fiber be traced from its termination on the digestive epithelium back to the cell-body from which it arose.

The fibers terminating on the digestive epithelium, doubtless, subserve a receptive function. They are probably the dendrites of neurones of the second type above described. These neurones would, therefore, be sensory in character. The axones of some of the neurones of the first type above described terminate directly on smooth muscle-fibers. These neurones are obviously motor in character. The distribution and the orientation of the neurones in these plexuses is obviously such as would be required by a system of local reflex arcs. That such a system of reflex arcs is present in the walls of the digestive tube has already been suggested by Dogiel, Müller and others. Indeed,

it is highly probable that the normal nervous control of the digestive functions is exercised primarily by the local sympathetic mechanism.

Amphimixis, Variability and Death; Some Facts and a Theory: L. B. WALTON, Kenyon College.

In connection with some studies on the variability of zygospores in *Spirogyra inflata* (Vauch.) formed by scalariform (amphimixis) and by lateral (quasi parthenogenesis) conjugation, certain facts are presented which allow an interpretation of the cause of death among organisms from a different standpoint than the generally accepted theory.

In 200 zygospores produced through the conjugation of cells of different filaments—sexual reproduction—the coefficient of variation is 9.5093 for length and 5.7471 for diameter. In the same number of zygospores produced by the fusion of adjacent cells of the same filament—comparable to asexual reproduction—the coefficient of variation is 11.9364 for length and 7.5376 for diameter, indicating for the given conditions that the cross-bred or sexually-produced zygospores, in themselves the young individuals from which the mature filaments arise, are relatively 20 per cent. less variable in length and 23 per cent. less variable in diameter.

Thus if amphimixis decreases variability, there is presented an interesting condition bearing not only on the problem of the origin of sex, but also on the origin of death, for the theory is equally applicable to the individual cell, whether isolated, as in the Protista, or associated in colonies, as in the higher animals and plants. The development of the body in multicellular organisms represents merely the development by asexual reproduction of an infinite series of cell individuals. Consequently the evidence suggests that death occurs as the result of the continually forming body cells becoming so variable through the absence of control by amphimixis, that eventually some one group fails to meet the limits imposed by the environment, and these together with the remainder of the colony—the individual—perish.

With a single exception, the available evidence is directly in accord with such a theory, although in general merely demonstrating that amphimixis does not increase variability (Warren, '99; Castell and Phillips, '03; Kellogg, '06; Wright, Lee and Pearson, '07). The investigations of Jennings, '11, on *Paramecium* seem to indicate that here conjugation increases variability. The evidence, however, was not altogether in harmony, in con-

sequence of which the subject was reserved for a future paper based upon additional investigations. Even granting that such is the case in *Paramecium*, where conjugation consists of a temporary union of gametes (conjugants), it would not necessarily follow that a similar condition would be found in organisms where a total and permanent fusion of gametes (copulants) occurred.

While it would seem that such a theory as here outlined is in advance of the earlier theories as to the cause of death which are purely speculative, there is need of additional data, and it is hoped that the several investigations now in progress may throw additional light on the subject.

On the Autonomic Nervous System of the Rabbit:

F. W. CARPENTER, University of Illinois.

The Variation and Ecological Distribution of the Shells of the Genus Io: C. C. ADAMS, University of Illinois.

Antero-posterior Dominance in Planaria: C. M. CHILD, University of Chicago.

In high concentrations of KCN, alcohol, ether and various other agents, which kill the animals within a few hours, the resistance of animals and pieces varies inversely as their rates of metabolism. In low concentrations, to which the animals become acclimated, the length of life varies directly as the rate of metabolism, because the animals or pieces with higher rate become more completely acclimated.

By means of these and other experimental methods the following conclusions have been reached concerning the dynamics of morphogenesis in *Planaria*: the anterior region has the highest rate of metabolism, at least during development, and from this a gradient in rate extends posteriorly; each zooid has a similar gradient of its own; because it has the highest rate of metabolism, the anterior region is dominant, both in morphogenesis and function, over the regions within a certain distance limit and in general any level is dominant over levels posterior to it and within a certain distance limit: the axial gradient in rate of reactions is the basis of organic polarity; by decreasing or eliminating this gradient heteromorphosis can be induced experimentally: the reaction-complex which gives rise to a head is the fundamental reaction-complex of the specific protoplasm.

The formation of a new head in the regulation of pieces of *Planaria* is not a restitution of a missing part, but the formation of a new individual head first and the new head region induces

the reorganization of the remainder of the piece. The head forms "in spite of" other old parts of the piece and not in correlation with them, but the new posterior end is the product of correlation with more anterior parts. In a series of similar pieces the frequency of head-formation and the character of the heads can be altered in either direction by agents which influence the rate of metabolism.

Observations on the Breeding Behavior of the Herring Gull: R. M. STRONG, University of Chicago.

Studies were made of the breeding behavior of the herring gull from the standpoint of modifiability, and especial attention was given to the voice of this bird. The report was illustrated by lantern slides. (To be published elsewhere.)

(1) *Maturation and Fertilization of the Armadillo Ovum.* (2) *Crucial Evidence of Parthenogenetic Cleavage of Ova during Follicular Atresia in the Armadillo:* H. H. NEWMAN, University of Chicago.

(1) The armadillo ovum is probably the most primitive Eutherian ovum known, in the sense that it shows a condition practically like that of the Marsupial *Dasyurus*. In the full-grown oocyte there is a cortex of formative protoplasm and a central deutoplasmic mass. During the process of maturation a radical change of polarity takes place, resulting in "telolecithal" condition upside-down. The deutoplasmic mass occupies the animal pole and the formative protoplasm lies at the vegetative pole in the form of a cap partially overlapping the deutoplasm. The maturation spindle is found in an equatorial position, i. e., as near the animal pole as possible without leaving the formative protoplasm. In other respects the maturation processes are essentially like those of other mammals. Only one fertilized egg was found, but this is very typical and is accepted as the norm for the species. There is but one male and but one female pronucleus and there are the usual two polar bodies. This furnished additional proof of the reality of polyembryony in the species.

The present investigation is the first study of maturation or fertilization processes in the Edentates. (To appear in *Biological Bulletin*.)

2. All previous observations concerning the alleged occurrence of parthenogenetic development in the mammalia have met with scant attention on the part of biologists. It is hoped that the present observations will meet a better fate. The following phenomena have been observed in ovarian ova

that have reached maturity but have been robbed of their chances of ovulation by the occurrence of pregnancy. The mature ovum, which has the condition described in the previous abstract, gets rid of its deutoplasmic mass by abstriction. The formative protoplasm then rounds itself up into a ball within which lies the large resting nucleus, probably the female pronucleus; the latter then forms a perfect cleavage spindle whose aster radiations invade the entire cell, and the first cleavage occurs. Equally unequivocal cleavage spindles occur in each of the first two blastomeres. Stages have been found with as many as four spindles visible at one time. In others two or three spindles and one or two resting nuclei occur in the same egg. The fate of the deutoplasmic material is peculiar and probably quite different from that in normal development. It fragments into a large number of cell-like bodies, with nucleus-like corpuscles composed of deutoplasmic granules, and at first forms a sheath around the formative cells. Subsequently these fragments are crowded between the blastomeres and bring about a condition of isolation of blastomeres. Evidently cleavage goes on considerably further, but, since there is at this time a tendency for stroma cells to enter the egg through breaks in the zona pellucida, it is impossible to be sure as to how much of the observed conditions are due to the development of the egg and how much is to be attributed to the activities of invading cells. The first few cleavages, however, are certainly the result of parthenogenetic development of the ovum. (To appear in *Journal of Morphology*.)

Preliminary Chemical Studies on Male and Female-producing Eggs of Pigeons. A Study of the Eggs of Forms in which the Dominance of Male and Female Sex and of White and Dark Color was Experimentally Determined by Professor C. O. Whitman: OSCAR RIDDLE, Carnegie Institution.

(Abstract published in *SCIENCE*, March 21, 1912, p. 462.)

Indications Regarding Differentiation from Tissue Culture Experiments: MARIAN L. SHOREY, Milwaukee Downer College.

Tissues of dogfish embryos from five to fourteen millimeters in length were found to grow equally well in saline solutions that contained, and those that did not contain, nutrient substances. As there seems to be no evidence that the embryonic cells of animals in which there is a distinct separation between the germ plasma and the yolk, as is

found in the dogfish, contain sufficient stored food to account for the amount of growth that occurs, the conclusion seems to be justified that the growing tissues receive their food supply from other tissues transplanted with them. Even when the culture medium contained both proteins and carbohydrates there was much more growth than when more than one kind of tissue was present.

In both my own experiments and in the published accounts of the work of others many tissues differentiate abnormally in the medium used, and in many other cases their identification with normal body cells seems at least to be doubtful. In other instances tissues which can be identified have been observed, but so far as I know these have never been found except when plasma was used or when more than one kind of tissue was present. The effect, therefore, either of the activity of these other tissues, or of their specific decomposition products, has not been excluded. This fact, taken in consideration with the instances of abnormal differentiation, while it does not demonstrate, seems to indicate that the differentiation of a cell depends not only on its own inherent properties, but also on the nature of its environment.

Some Recent Discoveries in Paleozoic Vertebrates:

S. W. WILLISTON, University of Chicago.

Some Early Embryonic Stages that Conclusively Demonstrate Polyembryonic Development in the Armadillo: J. T. PATTERSON, University of Texas.

The investigation reported in this paper had as an object the demonstration of polyembryonic development in the North American armadillo. It was shown that from late cleavage stages until after the two primary germ layers are laid down the differentiation of this egg represents a typical mammalian development. Upon becoming attached at the animal pole to the placental region of the mucosa the vesicle undergoes the process of "germ layer inversion," producing two secondary, incomplete vesicles, one lying within the other. The innermost of these soon becomes completed and may be called the ectodermic vesicle; the outermost remains incomplete on the placental side and is the entodermic vesicle. The region of the trophoblast which is in contact with the mucosa forms the Träger, while the distal or free part sooner or later sloughs off, leaving the entodermic vesicle directly exposed to the uterine cavity. The mesoderm arises as two pouches, situated at the right and left sides of the ectodermic vesicle. These expand and fuse together to form a char-

acteristic extra-embryonic body cavity, which occupies the space lying between the Träger and the proximal side of the ectodermic vesicle. The rudiments of the embryos arise from the ectodermic vesicle, and at first appear as two blunt outgrowths (the primary buds), arising from the right and left sides of the vesicle. Each primary bud, which lies directly above a mesodermic pouch, grows laterally and ventrally along the inner surface of the entodermic vesicle, and soon bifurcates at its distal end to produce two secondary buds, each of which represents the rudiment of an embryo. The secondary buds of the right side produce the pair of embryos previously designated the "dorsal" (III.) and "right-lateral" (IV.), while those of the left side form the "ventral" (I.) and "left-lateral" (II.). As a result of the failure of the primary buds immediately to complete division at their proximal ends, the two secondary buds of each side remain connected at these points. The further differentiation of each secondary bud to produce an embryo consists in its rapid extension as a finger-like process along the inner side of the entoderm towards the Träger, with which a placental connection is eventually established. The cavity of each secondary bud forms the amniotic cavity for the embryo, and the four cavities communicate in pairs with the original cavity of the ectodermic vesicle. This latter space remains small, and has been named the common amniotic cavity.

From these facts it is concluded that polyembryony in the armadillo is the result of a precocious budding, which apparently can not be correlated with the formation of the blastomeres of the four-celled stage.

Factors Controlling the Rate of Regeneration in the Frog Tadpole: C. ZELENY, University of Illinois.

(1) *Spermatogenesis in the Gryllidae.* (2) *The Puget Sound Marine Station:* W. J. BAUMGARTNER, University of Kansas.

(1) The germ cells of the male cricket show division figures which do not bear much resemblance to the illustrations shown by Vom Roth. There is no circle of four balls as he shows them, although he is correct in interpreting the tetrad as dividing longitudinally and transversely. The number of chromosomes is 23 and is reduced to 12 and never to 6 as Vom Roth has it.

One other important observation was made. One of the tetrads divides *unequally in the first division and the larger half always goes with the*

prominent accessory. This means that the accessory does not bear all the material which differentiates sex. It may further indicate that a second accessory chromosome is in the process of formation.

(2) The Puget Sound Marine Station was started as a seaside summer school of biology by the Washington State University. Later the other institutions of the state joined in the endeavor. In 1910 the educational institutions of other states were asked to cooperate in the work of the station. At present the following states have some of their institutions participating: Washington, Oregon, Idaho, Nebraska and Kansas. There is now provided a good laboratory, furnished with running fresh and salt water and electric lights. A large dining hall and 50 walled tents provide the living quarters. A dredge boat and many small boats with nets give abundant means for visiting the various islands and collecting the desired material. The climate is dry, cool and pleasant for summer work. But the station's greatest attraction is the almost inexhaustible supply of animal and plant life. The number and variety of species is unusually great and the numbers of many species are countless. (One hundred and ten slides, made from photographs of the animals, were shown, giving a glimpse of the life of the islands of Puget Sound.)

Observations on Protozoan Fauna of High Mountain Lakes of Colorado: C. H. EDMONDSON, Washburn College.

During July and August, 1911, twenty-one lakes, situated along the Colorado divide in Boulder, Grand, Gilpin and Clear Creek counties were visited and collections made from them with a view of studying the protozoan fauna of high altitudes.

Of these twenty-one lakes, eighteen are 10,000 feet or more in altitude, the highest being Summit Lake, 12,740 feet elevation. Collections were made on James Peak at 12,500 feet and on Mt. Evans at 13,000 feet.

Silver Lake and Lake Eldora were sounded and dredged for bottom fauna.

The lakes are shallow, Silver Lake, at its present height, is about fifty feet in depth; Lake Eldora about forty feet in depth.

During the summer the temperature of these high lakes ranges from 40 degrees to 50 degrees F.

Two species of *Diffugia*, found among others in the bottom of Lake Eldora, *Diffugia lebes* Penard and *Diffugia curvicaulis* Penard, are characteristic species of the deep lakes of Switzerland. Dr.

Penard has suggested that species common to the deep Swiss lakes and high elevations where conditions resulting from glaciers exist may represent a remnant of a glacial protozoan fauna.

Of the altitudinal range of the species observed the following is a summary:

Ciliates—over 11,500 feet altitude . . . 23 species.
Ciliates—over 12,000 feet altitude . . . 9 species.
Flagellates—over 11,500 feet altitude . 13 species.
Flagellates—over 12,000 feet altitude . 2 species.
Sarcodina—over 11,500 feet altitude . 54 species.
Sarcodina—over 12,000 feet altitude . 39 species.
Sarcodina—at 13,000 feet altitude . . . 2 species.

The great altitudinal, as well as latitudinal range, of some of our common species of protozoa is shown by the fact that twenty-nine of the species found in the high lakes of Colorado have been reported from sea level in the oceanic island of Tahiti in the southern hemisphere. A classified list of protozoa of the lakes of Colorado will appear in the University of Colorado Studies.

The Cerebrum of Necturus and the Problem of the Evolution of the Cortex: C. T. HERRICK, University of Chicago.

The Asymmetrical Distribution of the Polian Vesicles and their Correlation with the Retractor Muscles of Thyone: J. W. SCOTT, Kansas State Agricultural College.

As is well known, echinoderms have remarkable powers of regeneration. Under certain conditions *Thyone* eviscerates itself, throwing off the tentacles, esophagus, stomach, intestine, the calcareous ring, the ring canal with attached polian vesicles, the nerve ring, and the muscles which retract the esophageal ring. It was found that regeneration of all lost parts takes place after evisceration. However, to determine this fact it was necessary to study individual differences. For example, the number of polian vesicles varies from one to four, usually one, commonly two, occasionally three, rarely four. Both in size and number the polian vesicles show a strong tendency to occur on the left side. This asymmetrical distribution does not appear to have any present functional significance, and so must be referred to ancestral conditions. The additional fact was brought out that the number of retractor muscles varies with the number of polian vesicles. The average number of retractor muscles per individual increases as the number of polian vesicles increases; this is true in particular for the left side. Even after regeneration the same correlation holds true. The original asymmetry of each individual has re-

stored in all except one case; in this animal there was a change from single to multiple parts which included both polian vesicles and retractor muscles.

A full account with discussion of these results will be given in the *Journal of Experimental Zoology*.

The Distribution of North American Earthworms:
F. SMITH, University of Illinois.

In North America north of Mexico, scarcely fifty species of earthworms are known, which is less than five per cent. of the known species of the world. This small number is due in part to lack of study, but also to an actual lack of the variety usually found in territories of similar extent.

The genus *Diplocardia* is very characteristic of the region and includes species from Illinois, Nebraska, North Carolina, Georgia, Florida and Mexico. Other parts of the United States east of the Rocky Mountains doubtless have species. *Diplocardia* is a very primitive type of the family Megascolecidae and probably originated in North America as early as the Jurassic.

West of the Rocky Mountains are found a few species of *Plutellus* and *Megascolides*, of which genera the remaining species are found in Australia and India. These are primitive forms of Megascolecidae which presumably originated in Australia and representatives migrated from there during the Jurassic and Cretaceous by way of Siberia and Alaska into the Pacific region of North America.

The family Glossoscolecidae is represented by the primitive aquatic genus *Sparganophilus*, of which species are known from Florida, the Mississippi Valley, California and Mexico. This genus probably originated on this continent as early as the late Jurassic.

The family Lumbricidae includes the majority of the North American earthworm species. The most of them are also known in the Eurasian region, where they probably originated. The few endemic Lumbricid species of the United States are found chiefly in the states of the Atlantic region.

A few peregrine species of the Megascolecidae genera *Microscolex* and *Pontodrilus* are found in the coastal regions.

Probably few if any species will be found endemic in the glaciated parts of the continent.

Studies upon the Migratory Movements of the Pacific Coast Lobster: BENNETT M. ALLEN, University of Wisconsin.

Brass tags were affixed to 346 specimens of *Panulirus interruptus*, that were released at different times, at Santa Barbara, California, also at various points on the coasts of Santa Cruz and Anacapa Islands.

In all, 26 were caught and reported by the fishermen. The greatest distance traversed was 9½ miles in 28 days. The most rapid average rate of migration was .43 mile per day in the case of a specimen that traveled six miles in fourteen days. Eleven traveled less than one mile in an average of eighteen days. Eight traveled more than one mile in an average of twenty-seven days. The total average of distances traveled was 1½ miles in an average time of twenty-two days. The movements were haphazard.

Of the twenty-six caught, most of which were again released according to request, 5 were caught again—a third time in all. This investigation was financed by the Californian Fish and Game Commission.

The Chiasma of the Trochlearis Nerve: H. V. NEAL, Knox College.

The Habits of Fiddler-crabs: A. S. PEARSE, St. Louis University.

(To appear in the *Philippine Journal of Science*.)

Some Glimpses of Biological Conditions in Western Nebraska: R. H. WOLCOTT, Nebraska University.

(1) *Notes on the Rate of Growth of Freshwater Mussels.* (2) *The Fairport Biological Station:* R. E. COCKER, Bureau of Fisheries.

(1) *Karyosomes in the Ova of Passer domesticus.* (2) *Magnetic Control of the Movements of Paramacia which have Ingested Iron:* E. H. HARPER, Northwestern University.

(1) In the ovary of the sparrow in the winter the nuclei, particularly of the smaller ova, show an aggregation of the chromatin into karyosomes and absence of the chromatin net. These bodies have so definite an appearance as to suggest the possibility of definiteness in number. The count showed the probable number to be twenty-two, harmonizing with known results from the spermatogenesis which indicate the haploid number of chromosomes as eleven. On this basis, these bodies in the ova may be called the prochromosomes. Stages in the breakdown of the nucleoli to form the chromatin net were also shown.

(2) The question is raised whether the normal position of stable equilibrium with antero-posterior

axis vertical may have a directive influence in the negative geotaxis of these animals.

Paramœcium in its ordinary movements overcomes the effect of the slight difference of specific gravity that may exist between its ends, but as the negative geotropism is a delicate reaction elicited best in the absence of other stimuli it is possible that it may be a passive orientation due to a tendency of quietly swimming animals to fall into a direction affording stable equilibrium.

The specific gravity factor may be accentuated by ingestion of iron which lodges at first in the posterior end. In a control experiment with an electro-magnet acting at right angles to gravity overweighted animals which normally aggregate at the bottom are brought into circulation, swimming upward in the strong magnetic field, past the pole of the magnet and dispersing at some point above, causing a counter circulation to the bottom in the weaker portion of the field.

In such experiments with overweighted animals we have an example of obedience to the passive orienting tendency in the region where they are buoyed up by the magnet and of resistance to it in the region where they are not so supported. Internal stimuli induced by fatigue from swimming upward cause the change to the downward path. The downward movement may be broken up by recurring compensatory movements to make up for any passive deflections brought about by the action of gravity. In the upward movement, on the other hand, there is unbroken continuity unless interrupted by extraneous causes. It may be called a passive or mechanical tropism.

(To appear in the May number of the *Journal of Animal Behavior*.)

The Land Planarians of North America, with a Note on a New Species: L. B. WALTON, Kenyon College.

Since calling attention to the rediscovery of *Rhynchodemus sylvaticus* described by Leidy in 1851¹ the species has been found in abundance not only in Gambier but also at Urbana, O., and Meadville, Pa. The material from which the species was originally described was placed at the disposal of Girard by Leidy for study in connection with the former's paper on the planarians of North America.² Inasmuch as the specimens were in the possession of Girard at the time of the death of Leidy³ and were given him for use as he deemed

best, it is quite probable they are in the possession of some of the European museums, if in existence. Thus far it has been impossible to locate them, however.

Two specimens of a much larger species approximating 20 mm. in length and uniformly dark blue in color have also been taken in Gambier. For this the name *Rhynchodemus atrocyaneus* is proposed.

The land planarians of North America and the adjacent islands may be tabulated as follows: *Geoplana nigrofusca* (Darwin), Mexico and South America (common). *Geoplana stollii* Graff, Guatemala (a single specimen known). *Placocephalus kewense* (Mosley), cosmopolitan in hothouses, original habitat unknown (common). *Rhynchodemus sylvaticus* Leidy, East. U. S. (common). *Rhynchodemus atrocyaneus* Walton, Ohio, central U. S. (?) (two specimens known). *Amblyplana cockerelli* Graff, Jamaica (a single representative).

Land planarians occur under slightly decayed pieces of board, sticks, etc., particularly in grassy plots of old orchards, or lawns, usually in association with snails, the young of which they superficially resemble. The anatomical structure of the Ohio forms is being studied.

(1) *The Sense of Taste in Birds.* (2) *The Breeding Behavior of the Herring Gull:* R. M. STRONG, The University of Chicago.

(1) Chicks, doves, ducks and gulls were studied. The methods employed involved soaking the food which was given to the birds in various solutions. Chicks and ducks showed a dislike for food which had been treated with weak acids, sweets, table-salt and bitters. Quantitative experiments have been conducted for several months with gulls kept in captivity. These birds show a dislike for sour and salty solutions even when they are weak to the taste of the experimenter. The work with sweets and bitters is not yet finished for the gulls.

(To be published elsewhere.)

(2) Studies were made of the breeding behavior of the herring gull from the standpoint of modifiability, and especial attention was given to the voice of this bird. The report was illustrated by lantern slides.

(To published elsewhere.)

Peri-cellular End-nets in the Autonomic Cranial Ganglia of the Sheep: F. W. CARPENTER, University of Illinois. (Demonstration.)

W. C. CURTIS,
Secretary

¹ *Ohio Nat.*, p. 254, 1904.

² *Ann. Sci. Nat. Hist. Zool.*, p. 145, 1894.

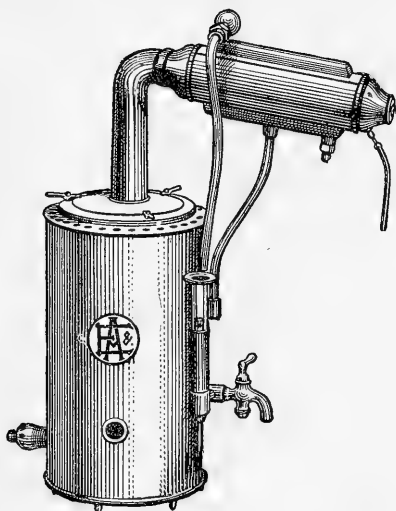
³ *L. c.*, p. 153.

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CHANCE AND THE PREPARED MIND¹

("In the fields of observation chance favors only the mind which is prepared."—Pasteur.)

It was at the opening of the Faculté des Sciences at Lille on December 7, 1854, that Pasteur, only thirty-two years of age at the time, but already professor and dean of the faculty, uttered these words in upholding, in his inaugural address, the value, on the one hand, of practical laboratory instruction as an aid to the solution of industrial problems, and on the other the importance of investigation in pure science, even though the resulting discoveries might have no immediate application. The point of view may have been novel when it was uttered, but in the sixty years that have elapsed how familiar it has become. How closely it approximates the ideals of those who are striving to improve the conditions of medical education and of medical research in our own day and country. What better argument can the most ardent advocate of detailed practical instruction in laboratory or hospital (medical training at first hand) present, than that which Pasteur offered in 1854. He asks:

Where will you find a young man whose curiosity and interest will not immediately be awakened when you put into his hands a potato, when with that potato he may produce sugar, with that sugar, alcohol, with that alcohol, æther and vinegar? Where is he that will not be happy to tell his family in the evening that he has just been working out an electric telegraph? And, gentlemen, be convinced of this, such studies are seldom if ever

¹ An address on medical education, by Richard M. Pearce, M.D., University of Pennsylvania, delivered at Syracuse University, May 21, 1912, under the auspices of the Alpha, Omega Alpha Honorary Medical Fraternity.

forgotten. It is somewhat as if geography were to be taught by traveling; such geography is remembered because one has seen the places. In the same way your sons will not forget what the air we breathe contains when they have once analyzed it, when in their hands and under their eyes the admirable properties of its elements have been resolved.²

Pasteur was a chemist, a physical chemist, if you will, and his illustrations were drawn from the realms of physics and chemistry, but if one substitutes for "electric telegraph" any piece of apparatus now in use in a medical laboratory or a hospital, the principle of the better type of modern medical instruction is embodied in his argument. He was talking to those who, after two years of practical and theoretical study, were to enter industrial careers as overseers and foremen in factories, foundries and distilleries. But neither time nor circumstance fundamentally alters the applicableness of his observations. After sixty years we may still urge his thought as the soundest of principles in the better education of men and women who are ultimately intended to enter careers as our overseers in matters of health and disease and as the foremen of public hygiene. Have our present-day medical schools succeeded in bringing to the training of their students the same practical and scientific thoroughness which Pasteur demanded for students in the industrial sciences and which students of the latter sciences now procure? If not, where lies the fault; in the college or the medical school, in the state or the public? Or are all more or less to blame? These questions will be discussed in due time, but first, let us turn to Pasteur's other proposition, investigation for its own sake. After stating his wish to be directly useful, personally and through

his laboratory, to the industries of Lille, he says:

Without theory, practise is but routine born of habit. Theory alone can bring forth and develop the spirit of invention. It is to you specially that it will belong not to share the opinion of those narrow minds who disdain everything in science which has not immediate application. You know Franklin's charming saying? He was witnessing the first demonstration of a purely scientific discovery, and people round him said: "But what is the use of it?" Franklin answered them: "What is the use of a new-born child?"

Do you know when this electric telegraph, one of the most marvelous applications of modern science, first saw the light? It was in the memorable year 1822; Oersted, a Danish physicist, held in his hands a piece of copper wire, joined by its extremities to the two poles of a Volta pile. On his table was a magnetized needle on its pivot, and he suddenly saw (by chance you will say, but chance favors only the mind which is prepared) the needle move and take up a position quite different from the one assigned to it by terrestrial magnetism. A wire carrying an electric current deviated a magnetized needle from its position! That, gentlemen, was the birth of the modern telegraph. Franklin's interlocutor might well have said when the needle moved "But what is the use of that?" And yet that discovery was barely twenty years old when it produced by its application the almost supernatural effects of the electric telegraph!

This, gentlemen, may seem trite to you, for it is an argument oft repeated, but its significance, as far as medicine is concerned, lies in the fact that at the time Pasteur made these statements modern medical investigation was just beginning. The celebrated physiological institute at Berlin had been in existence only sixteen years; Schwann, following Schleiden, had elaborated the cell doctrine only fifteen years before and anesthesia had been practised for only six years. Claude Bernard was in the midst (1850-60) of his important discoveries concerning the pancreatic juice, the glycogenic function of the liver and the vasomotor system; three years were

² Vallery-Radot, "The Life of Pasteur," McClure, Phillips & Co., New York, 1902.

to pass before Virchow established (1855) the first pathological institute and as many again before this great master was to announce the doctrine of cellular pathology; and finally, it was thirteen years before Lister's first publication concerning the antiseptic treatment of wounds.

In all these activities and those which followed, the ideal of seeking for the truth no matter where it might lead—the ideal of pure science—was the secret of that wonderful progress which medicine has made in the last seventy-five years.

Now, however, it is time to return to our text, "In the fields of observation, chance favors only the mind which is prepared." What did Pasteur mean by "chance"? His meaning is very evident in his example of Oersted and the magnetized needle. The mind which is trained to observe the details of natural phenomena, and to reason concerning the bearing of known laws on such phenomena, is the "prepared mind," that is to say, it is a class of mind which, because it is endowed with a peculiar faculty, best described as scientific imagination—grasps the significance of a new observation, or of a variation from a known sequence of events, and thus establishes a new law or invents a new practical procedure. To no man perhaps is this adage of Pasteur more applicable than to himself. It was his work in chemistry and his studies in crystallography that gave him the "prepared mind" which correctly interpreted the significance of the chance observation that the presence of a vegetable mould, the *Penicillium glaucum*, in solutions of salts of the tartaric acids, changed an optically inactive to an optically active fluid. He grasped at once the true interpretation of this reaction. The disappearance of the dextro-tartaric acid, the permanence of the levo-tartaric acid, could be explained only by the assumption that the ferments of this particular fermentation "feed more readily

on the right than on the left molecules." So did "chance" direct the "prepared mind" to those fundamental observations which established our present-day principles of fermentation, and which, as the result of work on alcoholic, acetic, lactic and butyric fermentation, led to Pasteur's final dictum:

The chemical act of fermentation is essentially a correlative phenomenon of a vital act beginning and ending with it.

It was but a short step for the mind thoroughly familiar with the principles of fermentation to embrace the opportunity offered by the study of the etiology of the infectious diseases, and so through all his work, as that in connection with the silk-worm problem, vaccination against chicken cholera and anthrax and the treatment of rabies, the "prepared mind" of the great master saw and appreciated the significance of every observation and every opportunity which presented itself.

Many other examples might be presented, as Semmelweis and his observations on the high mortality from puerperal sepsis among those under the care of students fresh from the dissecting and autopsy room and the low mortality among patients under other supervision. So also Lister and his anti-sepsis; and best of all, perhaps, for purposes of illustration, the sequence of Ehrlich's discoveries. We are told that in his student days Ehrlich was interested above all other things in the study of chemical affinities and worked incessantly with the new anilin dyes. Indeed the story goes that so engrossed was Ehrlich in his work that neglect of the required studies gave rise to some question concerning his right to receive his degree. The situation as described by Christian A. Herter³ was as follows:

³ Herter, C. A., "Imagination and Idealism in the Medical Sciences," *Jour. Am. Med. Asso.*, LIV., p. 423, 1910.

Although at this time Ehrlich was especially under the direction of the anatomist Waldeyer, he rapidly developed a capacity for chemistry which was a surprise both to himself and to the chemist, Adolf von Baeyer, whose lectures had been systematically cut by the gifted but unconventional student. For unconventional he then was, and ever has been, neglecting what he did not like and throwing himself with fervor and intense energy into the solution of the themes that attracted him. From the outset it was clear that Ehrlich would make a career as an experimental investigator. Much of the time he was supposed to spend in taking the usual medical courses he devoted to experiment. When Robert Koch was shown through the laboratory at Breslau by one of the professors, his attention was called to a young student working at a desk covered with bottles of dyestuffs. "There is our little Ehrlich," said the professor; "he is a first-rate stainer of tissues, but he will never pass his examinations." The prediction about the examinations came perilously near fulfillment; Ehrlich made bad flunks and it is hinted that he never would have received his degree had he not made a discovery—namely, the existence of the peculiar type of leucocyte which is known to us as the "plasma-cell." The faculty reasoned that it would be improper to keep so promising and original a worker indefinitely in an undergraduate position, and it is suspected that they mitigated the rigor of the examinations in order to relieve their own embarrassment.

These early studies were doubtless responsible for what must be considered as the main theme of all Ehrlich's work—the specific affinity which exists between specific living cells and specific chemical substances. The "prepared mind" is evident in his study of the cells of the blood, of the selective action of methylene blue on the nervous system, of the use of the same dye in the study of oxidation and reductions occurring in tissues, of his studies in immunity, of the specific treatment of protozoan disease, and also according to recent reports in his application of the same principle to the study of cancer. Manson's studies of the relation of the mosquito to filariasis, which led to Ross's study of the transmission of malaria by the same insect,

is another example of the "prepared mind" properly interpreting a chance observation. Sometimes such discoveries are referred to as the result of scientific imagination—and it truly is this—but doubtless the same "chance" came to many besides Pasteur, Ehrlich, Laveran, Koch, Theobald Smith, Manson, Ross and Reed; it was the training of these individuals, the mind prepared to utilize scientific imagination, that enabled them to grasp the opportunity offered by "chance" observation. Every one familiar with the history of investigation in medicine knows that before Harvey, men studied the circulation; that before Pasteur, bacteria were seen in diseased conditions; before Lister, the effect of cleanliness upon surgical mortality had been noticed; before Laveran, the plasmodium of malaria had been seen; before Manson and Ross, the possibility of the transmission of malaria by the mosquito had been discussed. Truly, remarkable achievements are never unique occurrences in nature. Even the greatest men rest on the shoulders of a large multitude of smaller ones who have preceded them, and epochal discoveries emerge out of a period of intellectual restlessness that affects many minds.*

But of these minds, it is that one which is "prepared," trained in the methods of observation, therefore possessing the priceless quality of scientific imagination, which sees the proper block which when placed exactly where it belongs completes the edifice of a perfect theory, and thus establishes a new landmark for future progress.

But what, you ask, has all this to do with the training of the physician? How does it apply to medical education? We admit the value of these qualities in the investigator, but of what value are they to the man seeking the education necessary to

*Flexner, S., "The Biological Basis of Specific Therapy," Ether Day address at the Massachusetts General Hospital, October 16, 1911.

practise medicine? Let me repeat Pasteur's adage—"In the fields of observation, chance favors only the mind which is prepared." Certainly all will agree that medicine is largely an observational science and one of the "fields of observation" of Pasteur's definition. Medicine may not be all science, but clinical medicine in its most essential phase—diagnosis—is essentially a science of observation, either of direct observation by the use of the unaided senses or indirect by the use of instruments of precision, or by chemical, biological or other tests. Therefore, whatever force or whatever lesson this adage may carry, applies to medicine. And now as to the interpretation of "chance." I have not been able to obtain the original French of Pasteur, but from his parenthetical phrase in connection with the discussion of the telegraph it is clear that he meant exactly what the translator has given us, chance or opportunity in the sense of an unexpected observation or an accidental occurrence. Pasteur's idea was that such unexpected or accidental occurrences would not arrest the attention of the poorly prepared mind, but that the well-prepared mind, trained to observe, to think and to compare, would grasp the significance of the unexpected, the unusual or occasional, put the observation to the test, by experiment or control, and arrive at the correct conclusion. Is not this a matter of daily occurrence in clinical medicine? Does not chance (opportunity some would call it) and care in details play an important part in diagnosis? Is not every ailment the physician sees a puzzle; every diagnosis, if correct, a solution of that puzzle? One speaks of the man who solves the puzzle which has baffled half a dozen other men, as a keen or accurate diagnostician. They imply that he has an added power, or that his skill is the result of wider experience, forgetting they may

have seen as many individuals with the malady as had the consultant, and perhaps totally ignorant of the fact that his diagnosis was possibly based on a chance observation which meant more to his trained imagination than it did to minds unaccustomed to weigh the significance of details. Every clinician of experience can give examples of the importance of chance and imagination in actual diagnosis. An interesting illustration is that

of the two students who reported on the same patient in competition for a clinical prize. The patient presented, among other symptoms, a remarkable discoloration of a certain area of skin, and the first student described this discoloration with the most careful minuteness. He measured it in different directions and drew a rough sketch of its general outline. The second observed the phenomenon with equal care, but he exercised his imagination and formed a hypothesis which he proceeded to put to the test. He asked a nurse for a wet towel, with which he wiped the discoloration away. It is evident that the faculty which he thus brought to bear on the problem before him would be likely to stand him in good stead in relation to many others of a more complicated character; and that his exercise of the art of diagnosis would be practically immune from the errors incidental to the habit of taking all appearances at their face value. Imagination at once points to the possibility of more than one explanation of any given occurrence, or alleged occurrence, and compels inquiry as to the existence of probable causes beyond the particular one which may at first sight appear to have been in operation.⁵

From what has been said, then, it should be evident that it is the first duty of a medical school to prepare men properly for the practise of medicine (and the most ardent advocate of research in the university will not deny that this is the first duty). If so, what are, conditions to be fulfilled to ensure the "prepared mind" of Pasteur's adage?

The Preliminary Education of the indi-

⁵ "Imagination in Medical Research," *Lancet*, 1912, CLXXXII, 179.

vidual is the first and in many ways the most important consideration. I know it is bringing coals to Newcastle to discuss this question before the students and faculty of Syracuse University, for you have been among the first to recognize the value of two years' college work which shall include physics, chemistry and biology. Still this principle is not generally recognized. Many of those in positions of authority in our medical schools, while loudly proclaiming the right of medicine to a place among the sciences and indeed characterizing it as the "Mother of the Sciences," deny that a scientific education is a prerequisite to medicine. True, the opposition is frequently due to a realization of the awkward financial position in which an administration might be placed if students' fees diminished. Frequently also it is due to the claims of those who hold that a greater cultural value lies in following the humanistic rather than the scientific school of thought. Naturally, there is also the "poor boy cry" and the closely associated cry that outlying districts will not be properly cared for if the cost of medical education is increased. The "poor boy" argument may be dismissed at once, for those who have had experience in teaching medicine know that the boy, poor or otherwise, who knows what he wants in the way of an education, gets that education in spite of all difficulties, and as a rule, if he has to work for it, is keen enough to get the best that is to be had. Such men will "come through" despite all apparent barriers in the way of higher preliminary requirements; if the indifferent "poor boy" fails, lacking ambition and a clear conception of what he wants, so much in favor of the higher requirements.

As to the outlying districts, we need have no fear as long as the ratio of physicians to

population is 1 to 568⁶ and the use of the automobile is increasing. If the ratio should change greatly, which does not seem likely, for only two states⁷ (North and South Carolina) have a ratio of less than 1 to 1000, the matter then becomes one for state regulation, for, as the report of the Carnegie Foundation has shown, we have enough physicians, but the difficulty lies in the tendency of physicians to seek the larger civic centers.

With the discussion of the cultural value of humanistic as compared with scientific studies, we are not concerned. It is sufficient that in a university medical school a man can not properly study modern medicine without that knowledge which comes from a familiarity with laboratory work in physics, chemistry and biology. The value of biological training for those interested in practical medicine was emphasized by Huxley many years ago, and that in physics and chemistry has recently been emphasized by Friedrich Müller⁸ in describing, for the benefit of the English Commission, the training of the German medical student.

During his first and second year,⁹ the medical student attends lectures and does laboratory work in physics, chemistry, botany and zoology in the philosophical faculty, and he has the opportunity of widening his views by listening to lectures on philosophical or historical subjects. His teachers and laboratories are the same as for the students of the natural sciences, and this is right, because there is no such thing as special medical physics

⁶ Flexner, A., "Medical Education in the United States and Canada," Bull. No. 4 of the Carnegie Foundation for the Advancement of Teaching, 1910.

⁷ *American Medical Association Bulletin*, 1910, V., 278.

⁸ Müller, F., "Memorandum on Medical Education Submitted to the Royal Commission on University Education in London."

⁹ The German student seldom takes his state examination until the end of five and a half years' work (Müller).

or chemistry; the physician requires a broad knowledge of the general sciences of physics and chemistry.

It is most important to have this statement of Müller's at a time when an effort is being made to place physics, chemistry and biology in the medical curriculum. With or without a fifth year it is a dangerous policy. The experience of one school in this regard is enlightening. During the period of change from a high school to a two-year college requirement, conditioned men were cared for by allowing time in the first half of the first year to make up conditions. The procedure took eighteen hours a week from the time which should have been devoted to purely medical studies. In such an emergency as that of a change of policy, this was perhaps justifiable, but what university school with a four-year course can afford this arrangement as a permanent policy? And if we are to have a fifth year, progress demands that it should be a clinical or hospital year, and not a preliminary year for work which belongs to the college. The modern curriculum of a first-grade medical school demands a student's full time and attention and no amount of general culture can make up for absence of prerequisites in physics, chemistry and biology. The school which allows mixed requirements, or low requirements or conditions does so at the expense of efficiency; the good men suffer on account of the slow progress of the poorly trained; the inefficiency of the teaching under such circumstances becomes noised about, and it comes to pass that the best-trained men go to schools which take only their kind, and thus eventually low standards react on the school allowing them.

But this is not all. Another factor, the state, is beginning to play an important part in determining the conditions pre-

requisite to medical education. Five¹⁰ states have passed laws demanding that for license to practise medicine an applicant must have had two years of college work as a minimum requirement, and four¹¹ demand one year. This, we must admit, is only the beginning. As state after state adopts the same ruling, schools not demanding such preparatory study must see the territory open to their graduates (and therefore the territory from which they draw students) gradually narrowed. Certainly, to-day, no school, and certainly no university school, can face with equanimity, this discrimination; and "disappointed indeed will be that student who, after having spent a large amount of time and money, finds on graduation that his diploma is not recognized in a large number of states."¹²

Methods of Teaching.—Within the medical school itself the matter of educational policy is clear. Here there can be only one procedure, the constant and consistent employment of the "do it yourself" or "learn by doing" method; the student must be taught to observe, experiment, reason and act for himself. This, I know, is trite, but the conditions out of which our present methods of medical education have emerged demand that this point of view be continually emphasized. It is not long since the day of the two- and three-year course and the imparting to undergraduates of all medical instruction, outside of anatomy and inorganic chemistry, by lecture. The development of the laboratory branches, histology, pathology, bacteriology, physiological chemistry and pharmacology—and the cheapening of physiological apparatus

¹⁰ Colorado, Indiana, Iowa, Minnesota and North Dakota.

¹¹ Connecticut, Kansas, South Dakota and Utah.

¹² *Jour. Am. Med. Assn.*, LVII, p. 1138, 1911; LVIII, p. 487, 1912.

—have given a new turn to medical teaching, that of active participation by the student. But still even in these branches the lecture still persists in most schools and frequently is so magnified in connection with the laboratory instruction as to make it appear in the eyes of the student as the most essential part of the course. The advance in methods and means of practical laboratory instruction—that is, the visible machinery for developing the principle of teaching by actual observation and experiment—would seem in some schools to be an equipment for advertising purposes only. One does not have to go outside the group of our so-called “big” schools to find a department of pathology, abundantly equipped with apparatus and a wealth of pathologic material, offering five lectures a week; and one may find an elaborately equipped student’s laboratory of physiology manned by assistants while the head of the department fulfills his duty to his class with three or four lectures a week; and likewise, in the clinical branches, few men have had the courage to do away with frequent and voluminous lectures. Even schools controlling a large hospital, and sometimes several, and thus having an abundance of clinical material, do the bulk of their teaching by the formal lecture and the amphitheater clinic. The ward class and the clinical clerk system gain ground but slowly. The reason for this attitude is easily found. The lecture is the easiest form of teaching, and the average teacher, whether he be the laboratory man overburdened by executive detail and handicapped by lack of assistants, or the clinical teacher limited in time by a busy practise, follows the lines of least resistance, forgetful, though sometimes resentfully so, of the best needs of his class. Usually coexistent with a pernicious lecture system is the habit of leaving those most favorable fields

for proper education—the laboratory exercise and the ward or dispensary class—to assistants. No one has less desire to belittle the work of assistants or to lessen their independence than have I, but in the department in which the head lectures only the student naturally assumes that the work of subordinates—in laboratory or clinic—must be work of subordinate importance, and thereby he comes to have a wrong estimate of the live part of his education. The most ardent supporter of the lecture system can not say that he always holds the interest of his class. He may hold their attention and be flattered by copious note-taking, but this has for its object only one purpose—the final examination. The real education—the training which means power and which characterizes “the mind which is prepared”—can come only through independent but wisely directed observation, experiment and reasoning on the part of the student.

I have discussed elsewhere¹³ how the latter system may be fostered, and am now glad to be able to reinforce my position by quoting from the recent very excellent address on this subject by Professor G. M. Jackson.¹⁴ As to the share of the teacher Professor Jackson says:

It is evident that each teacher must understand the curriculum as a whole. The laboratory man must be familiar with the clinical work. But this is not all. Since good teaching must take into account that which has gone before as well as that which is to follow, it is equally evident that the clinical man must be familiar with laboratory subjects and methods. We can not expect the best results in medical education until there is a better understanding and more cooperation between teachers of the various subjects all along the line.

¹³ Pearce, R. M., “The Experimental Method: Its Influence on the Teaching of Medicine,” *Jour. Am. Med. Asso.*, LVII., p. 1017, 1911.

¹⁴ Jackson, G. M., “On the Improvement of Medical Teaching,” *SCIENCE*, XXXV., p. 566, 1912.

As medicine progresses, all phases appear more clearly as varied manifestations of the same underlying biological science, and only when this is realized will the clinical and laboratory work be more closely knitted together.

As for the student, it is suggested that he work out everything for himself by the method of discovery. This applies not only to the original observations, but also to the latter process of reasoning, whereby we proceed from particular data to general conclusions, and thence to rational action. The method of self-activity may therefore be expressed in a negative way by the following practical rules: Never tell a student anything he can observe for himself; never draw a conclusion or solve a problem which he can be led to reason out for himself; and never do anything for him that he can do for himself.

There are, of course, limitations to the application of this method, as lack of time, an overcrowded curriculum, inability on the part of the teacher to fully grasp the situation, and failure to always maintain sustained effort on the part of the student, but its value over the lecture system is so great that it should be followed in "so far as practicable" (Jackson) and should be supplemented by demonstrations and conferences or recitations rather than by lectures, if one truly seeks to prepare properly for the practise of medicine.

Influence of the Spirit of Investigation.
—But aside from this training the university has another duty to the prospective practitioner of medicine. This is its duty in the encouragement of investigation, which is indeed a double duty, a duty to its students and a duty to the community it serves.

The question of allowing undergraduates to undertake independent original investigation is, I know, a debatable one. Certainly in most schools our overcrowded curriculum renders such work impossible unless a wise arrangement allows elective studies, as at Harvard in the fourth year, or as at Johns Hopkins in each year. My

remarks on this subject are therefore based on the assumption that an elective system is possible in every school.

As every teacher knows, each class contains a considerable number of men who desire to pursue work, to a greater extent than the conventional course allows, on certain subjects or by special methods, or less frequently, perhaps, they desire, and are usually well qualified to undertake, minor investigative work. To the former, as well as to the latter, any effort spent in work beyond that given the entire class becomes, necessarily, for them, the acquirement of the methods of research and as this means a knowledge of the exact, painstaking methods by which the realms of the unknown are explored, it is an exercise which prepares the student for the daily routine research work of the physician who truly practises his profession. As a training for future work, its value is definitely known and the increased zest and enthusiasm exhibited toward their medical work by men who have had this opportunity are always evident. Pedagogically, therefore, it would seem advisable that every student should have the opportunity for minor investigative effort, in order that he may become acquainted at first hand with the careful methods of experimental medicine. The bearing of the tangible results of his work on the subject investigated is a matter of little or no importance; the vital thing is the increased power which he himself acquires.

There is another way in which the encouragement of research aids the student, but which is possible only to those schools following the wise policy of appointing to professorial chairs, teachers who are likewise investigators. The influence of such teachers in the development of independent and resourceful practitioners is the secret of the great success of our better schools.

The correctness of this statement may be easily demonstrated.

If one examines courses in the same subject in a number of schools it is found that those which are best presented are under the control of men actively engaged in research work. Such men are alive to the advantages of new methods in their own subject and of new ways of applying old methods. Ever thinking and pondering about new methods of acquiring knowledge for themselves and their science, they appreciate better than does the non-investigator, that which will aid the student to acquire knowledge, and in their teaching they bring to bear on the problems which the student has to face the same methods of attack which they use in their own researches. On the other hand, one finds the men who never or only occasionally contribute to the literature of their science are the men who confine their teaching to perfunctory routine courses, with a profusion of lectures, and who never bring the spirit or methods of the investigator into their teaching. So, likewise, it is with the student taught under these two conditions. The student who knows that he is working in a department actively emphasizing new methods and striving to develop new truths, knows that his instruction is presented in the spirit of the department, and thus receives that stimulus and inspiration which insures his approaching clinical medicine with a proper appreciation of the scientific method. The student under the method of the non-investigator, on the contrary, has no incentive other than that of acquiring a knowledge sufficient to allow him to pass an examination.

An allied argument lies in the fact that the medical school that fosters research attracts the best-trained men as students. We have, as is well known to many of you, a medical school in this country which has,

for several years, arbitrarily selected from a large number of prospective matriculants the certain definite number which it desires; the rest, sometimes nearly fifty per cent. of those accepted, go elsewhere. Now this school has the highest requirements and perhaps the smallest alumni body of any prominent school in the country. It is not, therefore, a question of easy entrance or of the loyal influence of alumni, nor is it a question of better laboratory and hospital facilities, for other schools have equally good equipment in both respects. Likewise it is not a question of geographic location or center of population. The enviable position of this school is due solely to the policy of combining research with teaching and of appointing to its staff teachers who, with few exceptions, are also investigators.

As to the duty of the university to the community in the matter of research, there can be only one opinion. If the purpose of the machinery of medical education is to "bring healing to the nations," if the business of medicine is to "get people out of difficulties through the application of science and dexterity, manual and physical" (Cabot), then it is the duty of the university not only to teach known principles and methods, but to advance knowledge and methods by research.

It is futile to say that it is sufficient to teach and to utilize known methods of freeing people from difficulties, for the mere statement of such an attitude implies that an obligation exists to extend known methods, or to invent new ones, in the hope of overcoming difficulties acknowledged to be at present without remedy. The ethical force of this statement can not be denied. To teach a subject implies the attempt to diffuse the available knowledge of that particular subject matter among a number of people for their good, as well as for the good of the community in which they live

and work; equally true is it that such an attempt to teach available knowledge imposes upon the teacher the obligation to leave untried no means by which the knowledge of his subject may be increased. It is not the privilege of the teacher to leave this extension of knowledge to others. His profession of ability to teach a particular subject carries with it his obligation to the group or community he serves, of adding to his subject knowledge of which they may avail themselves. If this applies to the individual teacher, how much more forcibly does it apply to the university with its ever-widening community and ever-increasing interests?

On the other side of the question, the university should not forget that medical research tends to ameliorate social conditions by diminishing the causes of physical and mental ills. This ideal of medicine the university and its community should foster and develop, for it is one of the greatest influences in our modern conception of social service; an influence indeed which was back of all Pasteur's work, and which he expressed in the statement of his desire to contribute "in some manner to the progress and welfare of humanity."

But aside from this altruistic ideal, I hold that research in the medical school offers important practical advantages to the university and that these advantages should not be forgotten by university authorities, who pride themselves on applying business-like methods to the problems of education. A policy which attracts a better-trained class of students, which improves the character of the instruction, which stimulates the student to a better type of individual effort and which enhances the standing of the university in the community and the nation is a policy which can not be ignored by university president, trustees or faculty.

The Relation of the Hospital to Medical Teaching and Research.—That the laboratories of our better medical schools are fully equipped for the kind of instruction which I have outlined, and that many are already fostering the "do it yourself" principle and the spirit of investigation is well known. In the clinical years, on the other hand, the situation is not so satisfactory. Many a medical school while building and equipping modern laboratories has failed to care properly for its clinical teaching, and has continued to foster the amphitheater lecture. If the method of first-hand instruction, which I have outlined, is to be followed, then the hospital must become the laboratory of the clinical years and a school must own or absolutely control its hospital. This is necessary in order (1) that the heads of the clinical departments may have a continuous service under their immediate charge and to the conduct of which they may bring their own assistants; (2) that in connection with such service they may develop laboratories for teaching and research in addition to the usual clinical laboratory now used only for purposes of diagnosis; and (3) that resident physicians may be appointed for indefinite service in order that trained teachers and investigators in clinical medicine may be produced in the same way as trained teachers and investigators in the laboratory branches are now produced, and (4) that the head of the department may provide adequately for that intimate first-hand clinical instruction which can be secured only by placing the student in actual contact with the patient.

Some schools, as Pennsylvania, Hopkins and Jefferson, have already solved the problem by the establishment of their own hospitals. This is naturally the ideal course for all university schools and a future for which every school should plan. But in the absence of the possibility of im-

mediate consummation of such an ideal, results almost as satisfactory may be obtained by the actual affiliation of municipal or independent hospitals with the stronger medical schools. A hospital has as much to gain by this arrangement as has the medical school, for while the chief duty of the hospital must always be the care of the sick and injured, this duty, as well as its other functions—the instruction of men who are to practise medicine and the advancement of medical knowledge by research—is best served by placing the conduct of the hospital in the hands of men highly trained in the methods of scientific medicine.¹⁵ This would not only enable the hospitals

to fulfill a greater function in the development of thoroughly qualified physicians, but it would also be best for the patients, since they would have the benefit of the best methods of treatment under recognized experts. A campaign of education should be carried on to show our municipal authorities that the hospital will be the best conducted in the interests of its patients and the community at large, if at the same time it is fulfilling its function as a great center of clinical teaching and research.¹⁶

Many examples may be presented of the ideal association of charity, teaching and research as the results of such affiliation; the most striking perhaps being the magnificent clinic of Müller in Munich and the clinics of the University of Leipzig. Here, as in many other continental cities and in England, the university authorities by agreement with the municipal authorities appoint the heads of the hospital clinics. The long continuance of this arrangement and the great fame of most of these

clinics is sufficient proof that both municipal authorities and university authorities find it mutually advantageous.

We should bring about the same state of affairs in this country and, in fact, a start has already been made. At Cincinnati the large municipal hospital has been placed in charge of the clinical teachers of the University of Cincinnati; in St. Louis, the Washington University has made a close affiliation with the new Barnes Hospital; in Boston, Harvard has made an affiliation with the Peter Brigham and several other special hospitals; in New York, Columbia University and the Presbyterian Hospital have established similar relations; in Cleveland, Western Reserve University has formed a combination with the Lakeside Hospital; in Chicago, Rush Medical College has had for a number of years the medical control of the Presbyterian Hospital, and recently has made similar contracts and arrangements with the Children's Memorial Hospital, the Home for Destitute Crippled Children and the Hospital for Infectious Diseases.—Bevan.¹⁷

How much better such an arrangement would be than that which now exists. At present in most schools the clinical teacher is a teacher mainly because he is fortunate enough to control a hospital service, and for this reason has been appointed on the university staff. In his appointment the school has no choice, for it must have for its students the advantages of the clinical material which he controls. Whether he be good, bad or indifferent, as physician, teacher or investigator, he must be retained as long as he holds his hospital position. He, on the other hand, is handicapped by the regulations and restrictions of a not always sympathetic lay board of hospital management and, more important still, by the absence of proper laboratory facilities and the aid of his own colleagues in the departments of bacteriology, immunology, pathology and pathological chemistry. These departments are coming more and more into active participa-

¹⁵ For a discussion of the advantages to be gained by the hospital, see Welch, W. H., "Advantages to a Charitable Hospital of Affiliation with a University Medical School," *The Survey*, XXVII, p. 1766, 1912.

¹⁶ Bevan, A. D., "The Modern Medical School," *Jour. Am. Med. Asso.*, LVIII, p. 652, 1912.

¹⁷ Bevan, *loc. cit.*

tion in hospital work, in diagnosis, prognosis and treatment, and should be as closely affiliated with the hospital as are the clinical chairs. Those of you who have read "The Corner of Harley Street,"¹⁸ a most delightful series of letters by an English consultant, may remember the words quoted by the author from a lecture of a brother consultant to postgraduates. Said the lecturer:

Gentlemen, I should like the day to dawn when I could be met at the door of my hospital by a trained chemist, a trained bacteriologist, a trained pathologist, so that when I come to some complicated case I could say, "Chemist, a part of this problem is yours, take it and work it out. Bacteriologist, perform your share in elucidating this difficulty. Pathologist, advance, and do likewise."

These are not idle words. Since Ziemssen in the middle eighties established in Munich the principle of a clinical laboratory in the hospital, the idea has spread rapidly, until now every hospital worthy of the name has its clinical laboratory for the routine procedures of diagnosis. But this is not sufficient. The clinical chief must have the close cooperation of his colleagues in the departments of pathology, bacteriology, physiology and chemistry, and the student likewise must have the outfits of these departments at hand to aid him in his clinical studies. It is no longer enough to depend on the simpler procedures for the examination of urine, sputum, blood and other body secretions and fluids. The transportation across the city of tissues or fluids for examination in the laboratories of the school can no longer be countenanced. The progress of modern medicine, especially in pathological chemistry and immunology, demands for the benefit of the patient as well as for the proper instruction of the student, detailed and

oftentimes prolonged examinations under the hospital roof or at least within the boundaries of the hospital yard, and under the control not of assistants or internes, or dependent on occasional visits of a professor of pathology, bacteriology or chemistry, but under the constant supervision of such experts who do their teaching and research in the hospital and contribute their share to the diagnosis, care and treatment of the ills of the patients. This is the ideal of social service in medicine, the goal of all effort in medical education and research; and it is not Utopian. Already the University of Toronto has transferred its departments of pathology, bacteriology and pathological chemistry to the grounds of the hospital which furnishes its clinical instruction. Here not only the elementary instruction is given, largely aided by an abundance of fresh material from the hospital, but each advanced student serving as clinical clerk in the wards has always his desk, well-equipped locker and special outfit for the detailed investigation of his clinical material by laboratory methods, and moreover, has always at hand his teachers in the laboratory branches to aid him in his clinical investigations. It was my good fortune recently to go over these departments with Professors Leathes and MacKenzie, who explained their workings to me. When I expressed my satisfaction at the ideal union of clinical and laboratory methods Professor Leathes said quietly, and as if there could be no other point of view, "Yes, we expect a student working in the wards to use in diagnosis the methods of pathological chemistry as he does his stethoscope." Do you know what this means? It means that the amphitheater clinic and the didactic lecture are to follow the two-year and three-year course and that the methods and instruction of the

¹⁸ "The Corner of Harley Street, being some Familiar Correspondence of Peter Harding, M.D.," Houghton Mifflin Co., 1911.

laboratory years are no longer to be divorced from the clinical teaching of the later years of the curriculum. It means that men are to be trained by the "do it yourself" method to become practitioners with power of accurate diagnosis and the "mind which is prepared" to take advantage of every "chance" observation and opportunity. It means that the newer methods of biological, physical and chemical diagnosis, evolved through laboratory effort, are to work a transformation in medical teaching and medical practise analogous to that which came in the middle of the past century through the introduction of exact methods of physical examination. As physical diagnosis raised medicine above the plane of objective diagnosis and revealed the morphological changes in diseased organs of the interior of the body, so now the methods of physiological chemistry and immunology are destined to reveal the changes in the cells and fluids of the body which are dependent on intoxication, infection and altered metabolism and thus bring about an advance in methods of diagnosis, the fruits of which are almost beyond our powers of imagination.

Herein lies the most potent argument for close affiliation of school and hospital. The task, both from the teaching side and from the research side, demands united effort, common use of material and common financial responsibility. While any contract between university and hospital must leave the general support of the hospital in the hands of the hospital management, the school must be prepared to pay the salaries of attending staff, the cost of equipment and the expenses necessary for teaching and research and to assume the responsibility for the medical and surgical care of the patients and the general conduct of the scientific work. On the other hand, the

hospital should leave the matter of appointments, subject to its nominal approval, entirely in the hands of the school, with the understanding that withdrawal or resignation from the school automatically would sever connection with the hospital, and *vice versa*. Such an arrangement settles most of the problems of medical education. Continuous service and freedom in the appointment of clinical teachers come as a matter of course. Teaching and investigation can be carried on without interruption. The student becomes a part of the hospital routine and is not an onlooker with limited privileges. The laboratory departments of the first and second years unite to aid the work of the clinicians in the hospital. Clinical teachers may be promoted, if deserving, or may be called from any part of the country, or from abroad; the choice no longer depends on local hospital appointments or on the selfish interests and friendships of local consultants, but on fitness, eminence and skill.

Teachers may be appointed on a university basis, devoting all or most of their time to the care of the patients, to teaching and to investigation. The heads of the departments of internal medicine and surgery certainly should be so appointed. Under such circumstances these men with their staffs could control a large body of students working relatively independently among the patients in the wards and in the special laboratories in or near the wards. In these clinical laboratories every student should have his own desk and outfit for microscopic, chemical and other methods of examination. Not merely apparatus for the simpler tests should be supplied, but as well every facility for prolonged bacteriologic examination, animal inoculation and detailed chemical and physiologic study.

Such a plan insures diagnostic ability and therapeutic skill by training the powers of direct observation as well as by instruction in the methods of indirect observation through the use of instruments of precision and the procedures of the chemical and biologic laboratories. The experimental method emphasized in the laboratory years is thus continued through the clinical years. Laboratory procedures naturally fall into their proper place in relation to the methods of direct observation, and as the student approaches each new disease in the spirit of the investigator and not as an onlooker he gains a point of view which can not fail to have an important bearing on his work as a practising physician.

The Hospital Year.—So much for the preparation which the training, facilities and opportunities of the modern medical school should offer as leading to the degree of doctor of medicine. Should the state and the public demand more? Yes, the state, through its machinery for the protection of the individual, should demand a fifth year of hospital work, and this the public would force the state to demand if the easy-going public was thoroughly familiar with the insufficient requirements of many of our state licensing boards. Indeed, some states are already drafting laws to protect their citizens from the products of the poor medical schools of a neighboring state—

For example, the state of Minnesota has enacted a law enforcing an educational qualification as to the training of physicians who are allowed to practise in that state. The law was adopted in order to protect citizens of Minnesota against the graduate of commercial medical schools in neighboring states, and particularly of Chicago. In the present state of medical education such a measure is entirely justifiable.¹⁹

¹⁹ Pritchett, H. S., "Education and the Nation," *The Atlantic Monthly*, April, 1912.

Such a law not only protects the community against the improperly prepared graduates of the poor school, but it encourages the good medical school to increased efforts.

The hospital year as a prerequisite to licensure is to-day a live topic of discussion; to-morrow it may be in this and in other states a requirement legally stated.²⁰ Indeed it is difficult to see how the progressive state of New York, the educational system of which is so wisely controlled by a special board of regents, can much longer delay in establishing such a requirement. But why wait for the regents to force this upon the schools? Already 80 to 90 per cent. of the men in the better schools secure hospital appointments. Why should not the schools compel the small minority of those who do not secure a hospital to take a fifth year in clinical instruction in the hospital which it controls and thus be prepared for the requirement which must inevitably come in this and other states. I realize fully that the deans of our various schools are divided on this question. Some take the position that although the hospital year is an excellent requirement, the burden of finding the hospital instruction for all its graduates should not be placed on the school; that the duty of the university is ended when it has given four years of instruction and that the fulfillment of the added requirement is an affair of the individual. What does this mean in the last

²⁰ There is only one school at present which requires the fifth hospital year, and that is the University of Minnesota. No state boards at present require the hospital interne year. Those which to a certain extent have initiated practical tests at their examinations are Massachusetts, Minnesota, Ohio and North Dakota, and to a lesser extent practical tests are being used in Colorado and Michigan. (Personal communication from N. P. Colwell, secretary, Council on Medical Education of the American Medical Association.)

analysis? Simply this, that a school holding this point of view is either lax in its entrance requirements or at fault in its methods of instruction; otherwise it would not fear the failure of its graduates to secure internships. If this is true it has under the circumstances but one duty: as an educational institution, it must itself provide the fifth year of hospital work for its lame students. This is the point of view which is gradually forcing itself upon the school of the better grade, which, now that the pioneer stage of medical education is past, desires to itself complete the student's preparation, instead of turning him "over to others during this most valuable and important part of his preparatory work."²¹ The proposition of Professor Peterson, of Michigan, that the council on medical education of the American Medical Association should conduct an inspection and classification of hospitals on the same basis as the inspection of medical schools is most timely. The data thus obtained would do much to clarify the situation, and, doubtless, mutual agreements between certain schools and certain hospitals of the same class could be reached as to the distribution of graduates for interne service. Such a systematization would allow school and hospital alike to see their defects and to so rearrange their work as properly to care for the greatest number of properly prepared men. Only through the hospital year can we give the best type of practitioners to a most deserving but too confiding public; but to bring about the consummation of this ideal every university school and every community possessing a modern hospital must do its share.

These general remarks cover, in my opinion, the cardinal principles which

²¹ See Peterson, R., "The Relation of the Medical School to the Interne or Hospital Year," *Jour. Am. Med. Asso.*, LVIII, p. 723, 1912.

should guide the modern medical school. They can not, perhaps, in every community be enforced at once in their entirety, and doubtless now and then their adoption may be followed by backsliding, but no one who has given the subject serious thought can doubt that the future of medical education in this country depends on (1) the university school with a high entrance requirement, (2) instruction, in both laboratory and clinical branches, based on the method of observation and experiment, (3) clinical instruction in a hospital which the university owns or controls, (4) the principle of a fifth year of hospital instruction and (5) the fostering of the spirit of research.

And now finally let me congratulate Syracuse University on the high ideals it has set for itself in the conduct of its medical school. Your course has been watched by all who are interested in medical education. Your responsibility is greater than perhaps you realize; there are those praying for you to continue your present progressive system, others hoping you may fail. Each group desires to point to you as an object lesson. I have full confidence, however, that the wise trustees of your university, supported and encouraged by your alumni and the physicians of Syracuse and its surrounding territory, will not only maintain the present high standards, but will inaugurate still greater advances and thus ensure for the practitioner of medicine in this community the "prepared mind" of Pasteur's adage.

R. M. PEARCE

THE WORK OF COLONEL GORGAS

THE degree of doctor of laws was conferred on Colonel W. A. Gorgas by the Johns Hopkins University on June 11. In presenting him for the degree Dr. William H. Welch said:

Mr. President: In behalf of the academic council I have the honor to present for the honorary degree of Doctor of Laws Dr. William Crawford Gorgas, colonel in the Medical Corps of the United States Army, member of the Isthmian Canal Commission and chief sanitary officer of the Isthmian Canal Zone, formerly president of the American Medical Association, physician and sanitarian of the highest eminence, who by his conquests over pestilential diseases has rendered signal service to his profession, to his country and to the world.

With high administrative capacity and with full command of the resources of sanitary science Colonel Gorgas has given to the world the most complete and impressive demonstration in medical history of the accuracy and the life-saving power of our knowledge concerning the causation and mode of spread of certain dreaded epidemic and endemic diseases. He it was who, by application of the discoveries of Major Reed and his colleagues of the Army Yellow Fever Commission, was mainly instrumental in freeing Cuba of yellow fever, and he it is who, in spite of obstacles and embarrassments, has made the construction of the Isthmian Canal possible without serious loss of life or incapacity from disease—a triumph of preventive medicine not surpassed in importance and significance by the achievements of the engineer.

In the conquests of science over disease, in the saving of untold thousands of human lives and human treasure, in the protection of our shores from the once ever-threatening scourge of yellow fever, in the reclamation to civilization of tropical lands—in results such as these are to be found the monuments of our laureate, his victories of peace, to which this university now pays tribute by such honor as it can bestow.

SCIENTIFIC NOTES AND NEWS

The honorary degree of doctor of laws has been conferred by the University of Illinois on Vice-president Thomas J. Burrill and Comptroller Samuel W. Shattuck, both of whom retire at the end of the academic year after an active service of over forty years.

OXFORD UNIVERSITY has conferred its doctorate of science on Mr. A. P. Maudslay, president of the Royal Anthropological Institute of Great Britain and Ireland.

DR. E. RUTHERFORD, F.R.S., Langworthy professor of physics at Manchester, has been

elected a corresponding member of the Imperial Academy of Sciences, Vienna.

DR. L. A. BAUER has been invited to deliver the Halley lecture on "Terrestrial Magnetism" at the University of Oxford, England, in May, 1913. He was elected a fellow of the American Academy of Arts and Sciences at the annual meeting in May.

At the sixth annual meeting of the British Science Guild, held on May 17, a silver plate was presented to Sir Norman Lockyer, inscribed as follows: "Presented to Sir Norman Lockyer, K.C.B., LL.D., D.Sc., F.R.S., by members of the British Science Guild, on his seventy-sixth birthday, May 17, 1912, as a token of their esteem and as a recognition of his patriotic labors to promote the application of scientific principles to industrial and general purposes." Sir Norman was unfortunately prevented by ill-health from being present.

WE learn from *Nature* that Dr. D. H. Scott, F.R.S., president of the Linnean Society, has been elected a foreign member of the Royal Danish Academy of Sciences and Letters, and of the Royal Society of Sciences, Upsala.

It is reported that Professor Lanfranchi, of the University of Parma, who has been engaged for several years in the study of sleeping sickness, has been infected by the disease in a severe form, and has been taken to the Pasteur Institute in Paris for treatment.

PROFESSOR MAYVILLE W. TWITCHELL, head of the department of geology in the University of South Carolina, has resigned to accept the position of assistant state geologist of New Jersey. He will reside in Trenton where he will take up his new duties early in July.

At the meeting of the New York Section of the American Chemical Society, held on June 7, Professor Herbert R. Moody, of the College of the City of New York, was elected chairman of the section for the coming session to take the place of chairman-elect A. B. Lamb, who is going to Cambridge. The New York Section increased its membership over

a hundred during the past year, giving it a total of nearly a thousand members (962).

EDWIN B. FROST, director of the Yerkes Observatory, has sailed for England and will probably remain in Europe until next spring. In his absence, correspondence for the Yerkes Observatory should be addressed to Mr. S. B. Barrett, *secretary*. The duties of managing editor of *The Astrophysical Journal* have been assumed by Professor Henry G. Gale, of the department of physics, University of Chicago.

PROFESSOR F. R. MOULTON, of the University of Chicago, is sailing for Europe, where he will attend the International Congress of Mathematicians at Cambridge, England.

PROFESSORS R. BURTON-OPITZ and Frank H. Pike, of the department of physiology of Columbia University, have sailed for Europe. The former has a leave of absence until February, while Professor Pike will spend the summer abroad. Mr. Ernest L. Scott, of the University of Kansas, goes to Columbia as instructor in physiology.

PROFESSOR FRANCIS H. HERRICK, of Western Reserve University, will be absent on leave during the coming year in Europe.

DR. ALEŠ HRDLÍČKA, curator of the division of physical anthropology, U. S. National Museum, has gone to the Upper Yenisei region of Siberia, to carry on studies and collections for the museum and the California Exposition. From Upper Yenisei he will go to Irkutsk, and such other parts of Mongolia and Turkestan as he may have time to visit. After leaving Siberia he will visit Kiachтата in Chinese Turkestan, Mongolia, and then follow the road to Urga, whence he will proceed along the old caravan route to China proper.

DR. RILEY D. MOORE, aid division of physical anthropology, U. S. National Museum, and Mr. John B. Harrington, ethnologist, of the School of American archeology, Santa Fé, New Mexico, will make a trip to St. Lawrence Island, Alaska, to make observations on the tribe of Eskimo which occupies that island. The data and material gathered are to

be incorporated in the exhibits of the U. S. National Museum at the California Exposition in 1915.

DR. D. B. MACMILLAN, of the Crocker Land Expedition, and Mr. A. C. Bent, of the Smithsonian Institution, have left in the power boat *George Borup* for the coast of Labrador on an ornithological and ethnological expedition. It has been erroneously announced in the newspapers that Mr. MacMillan has sailed for Crocker Land, the expedition to which will be undertaken next year.

THE University of Illinois has celebrated the fiftieth anniversary of the passing of the Land Grant Act by unveiling the portrait of Jonathan B. Turner in the Illinois Farmers' Hall of Fame. President James in his commencement address on the Life and Labors of Professor Turner said: "All honor to Justin S. Morrill! But great as is the honor due to Mr. Morrill, the real credit for originating the plan incorporated in the Land Grant Act belongs to an Illinois farmer and professor, Jonathan B. Turner." The portrait of Professor Turner was presented by his daughter, Mary Turner Carriel, who was present as the guest of the university.

MAJOR GENERAL E. R. FESTING, F.R.S., known for his researches in physics and at one time director of the Science Museum, London, died on May 16, aged seventy-three years.

MR. B. J. AUSTIN, lecturer in physiology and hygiene at University College, Reading, and latterly emeritus professor of botany, died on June 2, aged eighty-three years.

THE U. S. Civil Service Commission announces an examination on June 5, 1912, to fill a vacancy in the position of agricultural propagator in the Philippine Service, at a salary of \$1,600 per annum, and of xylotomist, at \$1,000 per annum, in the Forest Service, at Madison, Wis.

THE annual meeting of the Swiss Association of the Natural Sciences will be held at Altdorf on September 9 and 10. A cordial

invitation is extended to American men of science to be present.

THE first International Congress of Comparative Pathology will be held in Paris, from October 17 to 22, under the presidency of Professor Roger.

THE proceedings of the International Radiotelegraphic Convention, at which thirty-five states are represented, were opened on June 4 at the Institution of Electrical Engineers, London.

INFORMATION has been transmitted to this government through the customary diplomatic channels, that the International Congress of Hydrology, Climatology and Geology, originally appointed to be held at Madrid from October 15 to 27 of the present year, has been postponed to the same dates (October 15 to 27), 1913. The participation of American scientists, scientific associations and higher institutions, is earnestly solicited by the Organizing Committee.

THE secretary of state for India has appointed a committee to inquire and report as to the facilities available for Indian students for industrial and technological training in Great Britain, with special reference to the system of state technical scholarships established by the government of India in 1904. The committee is constituted as follows: Sir Theodore Morison, K.C.I.E. (chairman), and Sir Krishna Gupta, K.C.S.I., members of the Council of India; Mr. J. H. Reynolds, M.Sc., lately principal of the Municipal School of Technology at Manchester, and Professor W. E. Dalby, M.A., professor of civil and mechanical engineering at the Imperial College of Science and Technology at South Kensington. The secretary of the committee is Mr. P. H. Dumbell, of the India Office.

THAT the forest cover of the White Mountains has a distinct and measurable effect upon the navigable streams which head in that region is the statement of the United States Geological Survey. The director of the survey has filed his preliminary report on the White Mountains with the National Forest Reservation Commission, and, as earlier

announced, the findings are favorable to the purchase of lands under the Weeks law. The report is based on the results of investigations and specific field tests which have been carried on during the last year. While the survey has been subjected to criticism owing to its refusal to submit a perfunctory report, assuming that a known and definite relation exists between forests and stream flow in the White Mountain region, the outcome of its investigations precludes the possibility of criticism by those who have opposed the acquisition by the government of any forest lands, on the theory that forest preservation does not affect stream flow. The hydrometric showing presented in the preliminary report covers results on two small, almost exactly similar drainage basins of about 5 square miles each, on the east branch of Pemigewasset River, one largely clothed with virgin timber and the other deforested and burned. Measurements of precipitation over the areas and of the run-off of the respective streams show that not only was the snow held better in the forested area, but that during a period of 17 days in April, including three extended storms, the run-off of the stream in the deforested area was a comparative flood—practically double that of the stream flowing through the forested area.

THE newspapers some weeks since contained the announcement of the discovery of a billion tons of iron ore in Fulton County, Pennsylvania, specifying red, brown and carbonate ores, ranging from 57 to 63 per cent. of iron, and found in Dickey's Mountain, Lowrie's Knob and the Meadow Ground. The geology of Fulton County is well known from the reports of the State Geological Surveys, and the impossibility of the case is apparent to any one who will read these reports and study the maps for a moment. A billion tons of iron would occupy a volume nearly equal to the mass of the three "mountains" named, and carbonate of iron when chemically pure contains only 48 per cent. of iron, and brown ore less than 60 per cent. Nevertheless, to ascertain what might have given rise to the reports, Director Smith, of the United States

Geological Survey, sent Geologist George H. Ashley into Fulton County to make an investigation. He reports that undoubtedly these hills contain several million tons of low-grade red iron ore and may contain a small amount of high-grade brown ore and more low-grade brown ore. Mr. Ashley found that three drill holes have been sunk into a shallow, canoe-shaped basin of red shale forming the "Meadow Ground." The basin is readily measured in length, breadth and depth. If all ore, it would hardly contain 30 million tons. The rocks are well exposed and show practically no iron except the iron coloring the rocks. Lowrie's Knob, if a solid hill of ore, would contain only about 100 million tons. The rocks here are likewise well exposed. A pocket of brown ore has been worked out on the east side by the old Hanover furnace, yielding about 75,000 tons of ore (46 per cent. iron). The "cove" fault runs through Lowrie's Knob and Dickey's Mountain, so that the rocks forming them stand on edge and locally are crumpled. Dickey's Mountain contains some low-grade sandy iron ore on the west side, possibly five million tons, as the bed cuts off against the fault. A little brown ore, 14 inches by 2 feet thick (38 per cent. iron), was dug for the Hanover furnace, but abandoned as impossible. The black shales of the Devonian are present in the region, but no suggestion of carbonate ore was seen.

A U. S. WEATHER BUREAU station has been installed at the University of Notre Dame, Notre Dame, Ind., by Mr. J. H. Armington, of the Chicago Station. Among the instruments located in the Science Hall, there is a triple register for wind velocity, wind direction, rainfall or sunshine as received on the roof by the anemometer, wind vane, tipping bucket rain gauge or sunshine recorder respectively. There are also two mercurial barometers and their barograph as well as complete equipment in the way of tables, record-books, report-books, etc., a few duplicate instruments and a snow gauge. There are on the roof, in a sheltered tower, wet and dry bulb, and maximum and minimum tem-

perature thermometers with their thermograph. Professor Thomas A. Irvin, Ph.D., of the department of physics, has charge of this station which, in conjunction with the university observatory, posts on the Science Hall Bulletin complete daily reports of meteorological and astronomical observations.

SIR WILLIAM HARTLEY has presented to the University of Liverpool a wireless installation designed mainly with a view to experimental and research work of an advanced nature. For transmitting purposes a short aerial about 100 feet above ground has been erected on the roof of the electrical laboratory, and in connection with this a standard Marconi receiver has been arranged such as is used on board ship, and this combination forms a small standard power station. This has been licensed by the post office, and time and meteorological messages are received twice daily from the Eiffel Tower in Paris. The transmission range is only about 40 or 50 miles, save under very favorable conditions, as the post office regulations limit the amount of power that can be sent out of a station to one third horse-power. Professor Marchant, of the electrical engineering laboratories, is at present engaged in testing detectors, but later in the year he proposes to hold wireless classes for ships' captains and others interested.

UNIVERSITY AND EDUCATIONAL NEWS

MR. WALTER MORRISON, of Baliol College, has given \$10,000 to Oxford University as the nucleus of a pension fund for professors.

J. CARLETON BELL, Ph.D. (Harvard), managing editor of the *Journal of Educational Psychology*, and director of the psychological laboratory in the Brooklyn Training School for Teachers, has been appointed professor of the art of teaching in the University of Texas. Dr. Bell will devote his attention chiefly to the experimental investigation of problems of teaching.

In the College of Medicine of the University of Virginia, as we learn from the *Journal of the American Medical Association*, Dr. Jacob Michaux, one of the original members

of the faculty, resigned the chair of obstetrics and was made professor emeritus of obstetrics. Dr. Paulus A. Irving, who has moved to Farmville, Va., was made emeritus professor of pediatrics. Dr. John F. Winn, formerly professor of clinical obstetrics, was elected professor of obstetrics, and Dr. Virginius Harrison associate professor of the same branch. Dr. Francis W. Upshur was chosen professor of materia medica and therapeutics, and Dr. C. Howard Lewis was made professor of pharmacology and also associate professor of physiology, these two physicians dividing the chair which was formerly held by Dr. Virginius Harrison. Dr. E. C. L. Miller was elected professor of bacteriology and physiologic chemistry.

MR. HARRY N. EATON, A.M. (Harvard, '06), instructor in geology in the University of Pittsburgh, has been appointed assistant professor of geology in the Pennsylvania State College.

At a recent meeting of the Yale Corporation, Jacob Parsons Schaeffer, M.D., Ph.D., was promoted from assistant professor to be professor of anatomy in the Yale Medical School.

NATHANIEL CORTLANDT CURTIS, professor of architecture in the Alabama Polytechnic Institute, has recently been elected to the chair of architecture in Tulane University of Louisiana.

E. S. McCANDLESS, a graduate of Purdue University of the class of 1908, has been appointed instructor in civil engineering in the Missouri School of Mines.

PROFESSOR B. H. HIBBARD, of the Iowa State College, has been appointed associate professor of agricultural economics in the College of Agriculture of the University of Wisconsin.

FRANCIS E. LLOYD, for four years professor of botany in the Alabama Polytechnic Institute, and plant physiologist to the Alabama Experiment Station, has been appointed MacDonald professor of botany in McGill University. Professor Lloyd's address will remain unchanged till September 10 next.

DISCUSSION AND CORRESPONDENCE

THE DOME THEORY OF THE COASTAL PLAIN

TO THE EDITOR OF SCIENCE: Recently the writer's attention has been called to an article published in SCIENCE of April 5 by Mr. G. D. Harris in which he claims the entire credit for the discovery and promulgation of the "dome theory" of the accumulation of oil in the Gulf coastal plain. The statements in this paper are so misleading to those unfamiliar with the history of the development of this region, that the writer feels it necessary to state briefly some of the facts and to quote some of the geologists who were familiar with the early work.

The article in question is as follows:

OIL CONCENTRATION ABOUT SALT DOMES

In several national, state and private publications the writer has called attention to the remarkable concretionary growth and bodily movement upwards of huge masses of rock salt in Cenozoic deposits along the Gulf border. The bearing of the structures produced in the neighboring beds by such growths and movements on oil concentration was duly set forth in Bulletin 429 of the U. S. Geological Survey. Recently he has had the opportunity of testing the value of his "dome theory" for locating oil "pools" in a region far away from any known oil occurrences. Reference is here made to Pine Prairie, south central Louisiana, where the Myles Mineral Company has had the courage to try out the theory and has discovered by the means a new oil field. The director writes: "I consider this a most remarkable vindication of a theory originated by you, and we attribute a large measure of our success thus far to your advice."

Space should not be taken here to discuss the probable exact location of oil in connection with these domes; that is a matter depending largely on the approach of the salt domes to the surface, size, location, etc. These matters have been outlined at least in the U. S. Geological Bulletin already referred to. But the location of oil by means of a theory unheard of ten years ago does seem worthy of record at this time. Another fact that should be impressed upon the mind of the public now is the absolute worthlessness of stocks in companies putting down wells "near" the dis-

covery well. This matter has, however, been discussed in Bulletin 429.

G. D. HARRIS

CORNELL UNIVERSITY

At the risk of presenting a rather personal matter, the writer will briefly outline the history and cause of his investigations of the coastal plain region during the past eighteen years in search of deposits of mineral value. As early as 1894 he bored with diamond drills on Jefferson Island, Belle Isle, Weeks Island and Anse La Butte, La., discovering in each place a huge mass of rock salt of limited area but of great depth. At Jefferson Island pure rock salt was penetrated to a depth of twenty-one hundred (2,100) feet without finding bottom, and at Belle Isle rock salt, having a depth of twenty-seven hundred and forty (2,740) feet (pierced in 1907), was discovered with paraffine oil and large lenses of pure sulphur.¹

The successful results attained by his explorations in Louisiana led the writer to extend the study of a nascent "dome theory" into Texas and to apply it to the various phenomena occurring on Spindle Top; a low elevation of only ten to twelve feet above the surrounding prairie, and to drill finally on this dome against the advice of his friends, with the well-known result that the largest well ever discovered in the United States and variously estimated at from 75,000 to 100,000 barrels per day had its birth on the tenth day of January, 1901.

The success of this well demonstrated the possibility of attaining economic results by drilling for oil, gas and sulphur on the domes of the coastal plain. This theory held good throughout the hundreds of wells drilled around Spindle Top in the effort to extend the area laterally without results, however, for it was subsequently proved that if the original well had been located only sixty-five feet further to the northwest there would not have been a discovery well.

¹ See "Rock Salt in Louisiana," by A. F. Lucas, in *Trans. Am. Inst. Min. Eng.*, 1899, also *Jour. Ind. and Eng. Chemistry*, Vol. 4, No. 2, February, 1912.

It must be noted that this well was not located on the axis of "the central dome," hence the great risk incurred in its drilling, and whoever may claim that this dome theory does not apply, and "fools" around the rim of the dome, stands a good chance to lose himself in the quagmires of gumbos and the unconsolidated sands with which the domes are surrounded. This was proved by hundreds of wells drilled around the Spindle Top dome, not in an effort to prove a theory, but rather in the strenuous effort to extend laterally the area of the productive territory. The dome theory as advanced by the writer in the early days of the Spindle Top field to Dr. C. Willard Hayes and Professor R. T. Hill, of the U. S. Geol. Survey, to Mr. Lee Hager, consulting geologist, Houston, Texas, Dr. Wm. B. Phillips, now director of the Mineral Survey, Austin, Texas, and to Mr. Eugene Coste, of the Canadian Mining Institute, has been generally accepted.

Mr. Hager, in a letter to the writer, dated May 27, 1912, from Houston, Texas, writes as follows:

All of us down here, at least those who know the facts, are fully aware that the credit of first bringing the significance of these coastal domes to the attention of the world belongs solely to you, and I can not see that there has been any advance made upon your ideas even to this day.

Professor R. T. Hill, in the *Jour. of the Franklin Inst.*, Aug. and Oct., 1902, and in *Trans. Am. Inst. Min. Eng.*, Vol. 33, states:

Before the discovery of Spindle Top there was only one man whose ideas—although not yet co-ordinated into a theory—approximately fitted the observed conditions. Of course I refer to Captain Lucas, who, in his explorations of the Coastal Plain, seeking successively salt, sulphur and oil, had observed the associations of oil, sulphur, sulphuretted hydrogen, gas, gypsum, dolomite and salt, constituting collectively what might be termed the oil-phenomena representing a group of secondary products as distinguished from the mother-strata or sediments out of which they have been produced. Moreover, so far as I am aware, he first pointed out the existence of anticlinal hills in the Coast Prairie and their connection with the oil-phenomena. . . . Captain Lucas early noted that

sulphuretted hydrogen escaping from the earth under certain conditions deposited sulphur in crevices near the surface. Such phenomena he observed at Spindle Top before commencing his well. At High Island, Galveston County, Texas, work was temporarily suspended on a well hole and the orifice stopped with hay in order to prevent obstructions from debris. Afterwards when the plug was withdrawn the hay was found to be imbedded in a matrix of sulphur, undoubtedly deposited by the escaping gas. . . . No topographic surveys have ever been made of any portion of the Coastal Prairie, and hence the slight irregularities of its contour are discernible only with difficulty. Until Captain Lucas's investigations, certain low elevations which have since become the most important features of the landscape were hardly noticed. I allude to low swells or hills, such as Spindle Top, which occur here and there and now attract attention from their supposed relation to the occurrence of oil beneath them. . . . In the generally monotonous monoclinical structure there are a few wrinkles or small swells likely to escape the eye of even the trained observer, and yet of a character which may have an important bearing on the oil problem. These are the circular or oval mounds already described which were first recognized by Captain Lucas. When he pointed out Spindle Top hill to me, my eye could hardly detect it, for it rises by gradual slope only ten feet above the surrounding prairie plains. I was still more incredulous when he insisted that this mound, only 200 acres in extent, was an uplifted dome. But Captain Lucas said that I would be convinced of the uplift if I could see Damon's mound in Brazoria County. In August, 1901, I visited that place and then returned for a second look at Spindle Top and was convinced that if these hills are not recent quaquaversal uplifts no other known hypothesis will explain them.

Mr. Marius R. Campbell, a later but impartial judge, in summing up the progress that had been made,² states:

In the general wave of oil explorations and development that swept over the country from the Appalachian region, when that was at the height of its production, oil was found at Corsicana, Tex., in flat-lying rocks that were similar in geologic structure to the rocks of the mid-continent field

of Kansas, and it seems to have been generally assumed that there were no new problems in the oil fields of the Gulf coast. Captain A. F. Lucas, however, was not of this opinion. For years he had been exploring the salt beds of Louisiana, and he appears to have been the first to fully appreciate the dome structure of such deposits, and to have been imbued with the idea that they contained not only salt and sulphur but also petroleum. His famous gusher on Spindle Top near Beaumont, Texas, struck oil January 10, 1901, and fully demonstrated the correctness of his theory, although this was not generally accepted by the geologists best acquainted with the field. Some endeavored to convince the public that the conditions at Spindle Top were similar to those at Corsicana, and that the pool would be found to have considerable lateral extent, but the oil drillers soon disproved this idea, and showed that oil was practically limited to the dome and small mound which constituted its topographical expression.

There are scattered throughout the Texas Coastal Plain many well-known domes which have been prospected directly or indirectly by the writer, the most important of which are known as Saratoga, Sour Lake, Big Hill, High Island, Damon Mound, Keiser Mound, Barber Hill, Hoskins Mound, and Bryan Height. In the last-named mound the writer found in 1901 hydrogen sulphide under heavy pressure and also native sulphur which is now being heavily exploited by a New York syndicate, which hopes to make this equal to the sulphur mines of Louisiana. Whether or not this mound is also a salt dome remains to be proved by deeper drilling.

In conclusion it appears that the claim made by Mr. Harris in locating wells at Pine Prairie, as noted in his article in *SCIENCE*, quoted above, was quite premature, as *The Oil and Gas Journal*, of May 23, states:

Pine Prairie, that had promise of developing another Gulf coast field, has so far failed to produce other than disappointments. Of the five tests now drilling three are at depths considerably past that at which the Myles Mineral Company found pay in its No. 8, the discovery well, and have failed to drill into anything encouraging to test. The Producers Oil Company set screens in No. 1 Le Danois-Hudspeeth at about 2,000 feet and made a try for a well, but the effort failed to be pro-

² *Economic Geology*, Vol. VI., No. 4, June, 1911.

ductive, and as a result the pipe has been pulled out, broken down and the hole abandoned.

A. F. LUCAS

WASHINGTON, D. C.,
June 3, 1912

UNIVERSITY CONTROL

LETTERS FROM YALE UNIVERSITY

It is quite unnecessary for me to speculate regarding what such a system as you propose would be. Exactly this system is in effect in New Haven. In fact Yale University consists of a collection of separate schools. Each has its own funds and almost complete autonomy. These funds are indeed held by the corporation and president, but in the main each department spends its income as its own judgment dictates with little interference from the university authorities. Each faculty nominates to the corporation its own new members, and as the corporation nearly always confirms nominations this amounts to election by the faculty. Each faculty elects its own dean who presides over its meetings. Its committees are either appointed by the dean (never by the president) or elected by the faculty itself. Such conditions fulfill almost exactly the suggestions of your pamphlet. The question is then: Does this system of university government attain the objects to which you look? I gather from your pamphlet and from previous articles of yours that the happiness of the professor is the principal object toward which you are striving. This is certainly achieved at Yale to a degree equalled, perhaps, nowhere else in America. Of course, satisfaction with one's position makes for loyalty and other incidental advantages; but is the happiness of the members of the faculty the principal object for which a university exists? Is not that form of university government best which provides the most ready adaptation of the university to the community which it serves? Ought not any form of university government to be judged by the degree of progressiveness of the institution having this government? I am inclined to believe from personal observation that in spite of all the advantages of democratic government which Yale enjoys—and which any university planned as you sug-

gest would doubtless have—a more centralized control would make for great interdepartmental cooperation and a more ready adoption of new measures than is afforded by such democratic government. After all every institution inevitably adapts itself to the views of the masters whom it serves, that is, to those from whom it obtains funds. The state universities depend upon the people of the state, the endowed universities upon their alumni. It is an article of faith with every loyal alumnus that his alma mater is perfection. With a body of "loyal" alumni viewing every change with suspicion and with a faculty thoroughly satisfied with things as they are, there would not be under the system of government which you propose any sufficient machinery for the initiation of change. There are few—if any—of the endowed universities at least which would not in my opinion benefit enormously from having a Woodrow Wilson in the presidential chair. Certainly the one institution that has enjoyed this advantage failed to reap the full benefits therefrom, because the presidency carried with it too little power and the other elements in the university too much.

There are many things in the statement which are in harmony with my own views. I have always been, and still am, a strong believer in the desirability of autonomy for the individual schools or departments of a university. To-day our universities are so large and so complex in character that it is impossible to have adequate control over all the varied interests of the university in the hands of a central body. I believe in the desirability of a corporation, or board of trustees, in whom rests final authority for all matters pertaining to the university; but I think that the initiative, the control and the general management of a department or school of the university should rest in a governing board or subcommittee, whatever you choose to call it—with a chairman or dean or director, who is given, subject to said board, a large measure of authority. The corporation of the university should be representative of all the interests of the university, so far as possible. Here at

Yale, where alumni representation is perhaps as strong as in any university, we have been reaching out of late years further and further, so that to-day we have on our corporation various men elected from the alumni; but in addition we have what is called an alumni advisory board, a body composed of representative alumni from all over the country; but while having no real authority, they are able after discussion among themselves to present to the corporation suggestions and advice, sometimes of great value. This, no doubt, is a move in the right direction. I have advocated, however, what I see you advise here, the desirability of a movement in the other direction, namely, of closer relationship between the corporation and the professors or other officers of the university. At present, in most institutions, if not in all, the president is the sole person on the board of trustees or on the corporation who is supposed to be in touch with the activities of the faculty or faculties. At present, however, with the large size of the university, the president does not have, and can not necessarily have, an intimate knowledge of what is going on. I believe, therefore, very thoroughly in the idea of direct or indirect representation on the corporation of the university of the faculty in the persons of say three professors, who might sometimes be the deans of the individual departments. In your third paragraph regarding the unit of organization within the university, you have outlined exactly what we have in force here. Thus, in the Sheffield Scientific School, the scientific department of Yale, our governing board, composed of permanent professors, about twenty-four in number, is the deliberative and active body, subject of course to the corporation. The size of this group is such that it is thoroughly efficient. Your fourth paragraph is likewise in harmony with our customs and our beliefs in the Sheffield Scientific School. The director is elected every five years. He is given a large measure of authority, but all the same he is subject to the governing board of the school, and there is a very distinct autonomy. Professors and assistant professors, and indeed instructors, are

all selected by the governing board, or in practice by committees appointed by the governing board, subject to their approval. Nominations then go from the governing board to the corporation for confirmation. Regarding the salaries, personally I am a strong believer of having the salary the same for all officers of the same grade, subject possibly to advances on the basis of years of service.

(1) Approved, except that the treasurer should be responsible to the president, as otherwise he could hamper the actions of the president by lack of financial support. (2) The professors should elect the president to continue in office at the pleasure of the trustees and removable only by the trustees. I think his salary should be larger and his position more dignified. I do not believe in electing an executive officer and then not letting him execute. The present autocratic attitude of certain presidents would tend to be limited if they were elected by the professors and the professors were able to remonstrate to the trustees; but it is equally clear that the efficiency of the president should not be hampered by the necessity of keeping in favor with all the professors. (3) Approved. (4) There is danger of professors being required to waste too much time in executive work and keeping to themselves powers which should be delegated to executive officers. I think the president should assume the burden of finding candidates, weighing their qualifications, deciding what positions should be filled; but he should do this in consultation with committees of the professors and his action in regard to all appointments should be ratified by faculty vote. (5) The idea of general faculty meetings at occasional intervals is a good one, though as you state not much business can be transacted in such a large body. In conclusion, I would differ from the plan outlined in conferring more working power on the executive officers and leaving the professors free for teaching and research, but at the same time make the executive officers responsible to the faculty as well as to the trustees.

On the whole I think I approve of the policy you set forth. There are minor details I should wish to consider more. You know that to a very considerable degree what you advocate is the plan at Yale University. Our departments and notably this school are in great measure autonomous. It seems to work well here. It has long been a question in my own mind if a unit of 1,000 students with the necessary instructors, buildings and equipment was not as large a one as could be handled by one man as president, dean, director or what you will to obtain maximum efficiency. This in a way seems to be the army view of it, where the regiment of about this magnitude of unit has its colonel. The kind of management that a colonel must give is what I think one should expect (the difference between the two affairs being properly considered) from a dean or director. I mean that personal supervision of matters that comes of personal knowledge. And when the university is 5,000 in size the president would do well to become a general.

I think you are correct in believing that our universities need remodeling. We have a democracy here at Yale and yet the most effective administration is in the Sheffield Scientific School, where democracy and autocracy are combined. After all administrative heads must have power to act and a good administrator does not work well hedged in by all sorts of limitations. It takes the snap out of one to work under restrictions. The more I see of democracies, the more I come to believe in a limited monarchy.

The more I see of university management the more I feel in a cloud as to what is the best thing. At the present time I haven't any definite opinions on the subject. All I can say is that to me the question of the actual formulation of rules to govern a university is much less likely to have a real influence than the spirit and ideas of the people connected with the university. I can not help thinking that the latter will be the dominant factor, whatever organization may be laid down.

I thoroughly agree with the proposed plans (3), (4), (5), in their essential details. Your views on these points are, I believe, correct. With regard to (2) my reply would depend somewhat on the interpretation of your words. The expression "expert knowledge of education" is the point at issue. Our college and university presidents ought in many cases to talk less and become more familiar with the men, *i. e.*, teaching staff and their work. I am not at all certain that your further suggestions under (2) are expedient. Suggestion (1) does not appeal to me as presented. I do not believe in extreme democracy. However, I prefer to omit discussion of this point, as I have never given any serious thought to it.

I do not wish to be drawn into the discussion. I wish to tell you, however, that I heartily approve of the policy of SCIENCE to air the university situation. Its fearless attitude is very needful, in my humble opinion.

I am in accord with the general principles. At the present time the president of most American universities is "neither fish nor flesh nor good red herring." He is so overburdened with administrative duties that he is unable to inform himself as to the educational aspects of the different departments of the university. I speak feelingly on this point because I have been more or less intimately connected with several university medical departments, and it has been my experience that university presidents need about as much education on the subject of medical schools as ordinary intelligent laymen. I dare say the same is true of law and divinity schools, etc. I do not mean to deny that there are brilliant exceptions to this general statement. I am therefore very strongly in favor of the division of the work now accomplished by university presidents into an executive portion, to be taken care of by a chancellor or some similar officer and a board of trustees, and an educational portion, to be overseen by a trained educator. When you come to think the matter over there are singularly few col-

lege presidents who hold that position on account of special training. I agree also as to the unit of organization consisting of the school or department, that being the natural and logical unit. I also agree in the main with the machinery proposed in paragraph (4). The only inadvisable thing, to my mind, would be the constitution of a permanent board of advisers—if you mean it to be permanent. I would add that it might be wise to set a time limit upon the deanships—or directorships—whatever you care to call them. Personally, I doubt very seriously whether a single individual should be the controlling force in a department for more than ten years. Your fifth section, which proposes the senate and the plenums, I think is also desirable. I assume that this senate and the plenums would legislate regarding the educational policy rather than regarding the financial policy.

I heartily approve of your scheme for university control. In our university, as in others, the head of a department has altogether too much power—or uses it too arbitrarily. In fact, members of the faculty scarcely dare to oppose his plans or to vote against his reelection, for fear of reprisals, unjust discriminations, etc. Thus a president or head of a department may become a sort of dictator, or like a political “boss.”

Your reprint is a very moderate statement of the evils arising from the present system of college and university control. The worst of these evils is probably its discouraging and deterrent effect upon the men exercising the teaching functions in this class of institutions. And if this system continues without essential modifications, this form of its evil results is likely to grow with constantly accelerating rapidity. Self-respecting and gifted and independent men will not choose a career which may at any time be cut short or even totally ruined by the caprices of a presidential “boss.” For myself, and much as I love and highly as I prize the office of the teacher, I should hesitate long before accepting, were I again young and asked, under the changed

conditions, to enter the life of a college or university professor. As in all similar cases, the remedy is by no means so clear as are the evils demanding a remedy. I am inclined to think that the details of any change of plan would need to differ in different institutions. Certainly they could not be precisely the same for the private and the state institution. And in both cases, care would not be of small importance to avoid changing the benevolent despot for the uncontrolled mob. It would seem also that some means should be devised for placing the control of instruction and the control of finances in largely different hands, while securing frank and cordial intercourse between the two.

SCIENTIFIC BOOKS

The Biology of the Seasons. By J. ARTHUR THOMSON. Illustrated by WILLIAM SMITH. New York, Henry Holt and Company. 1911.

The Natural History and Antiquities of Selborne, in the County of Southampton. By GILBERT WHITE. With illustrations in color by GEORGE EDWARD COLLINS, R.B.A. London, Macmillan & Company. 1911.

It is worth while to consider these two books together, for resemblances and contrasts. They are typical of the centuries to which they belong, of the old and the new in natural history. Professor Thomson points this out, in his introductory chapter. “The older naturalists—before Darwin’s day—made many careful pictures of the life of plants and animals as it is lived in nature. The indefatigable patience, the keen observation and the sympathetic insight of many of these pre-Darwinian naturalists must remain as models to which in these later days, with improved methods, we try to approximate. Gilbert White’s ‘Selborne,’ above all, remains evergreen. But the old records are for the most part contributions to Natural History rather than to Biology. To most of their authors there was wanting the biological key which Darwin first taught men to use.” But in post-Darwinian writings “biological ideas have become dominant; analysis has become more penetrating; the pictures have a broader

perspective and a deeper insight." In the books before us, however, there is a contrast in the attitude toward the reader as well as toward the subject. Listen to Gilbert White: "If the writer should at all appear to have induced any of his readers to pay a more ready attention to the wonders of the Creation, too frequently overlooked as common occurrences; or if he should by any means, through his researches, have lent a helping hand towards the enlargement of the boundaries of historical and topographical knowledge; or if he should have thrown some small light upon ancient customs and manners, and especially on those that were monastic, his purpose will be fully answered." Simplicity and humility enough, but the offering consists of his own "researches," presented in the hope of somewhat enlarging the bounds of human knowledge. Now Professor Thomson: "That the method of seasonal biological study is educationally sound is best proved by experiment. But it is perhaps enough to ask the simple question: *What kind of scientific lore concerning living creatures would we most naturally teach our children in spring?*" The attitude is pedagogical throughout: the author has come to instruct—as pleasantly and interestingly as may be, but never forgetting that he is a teacher. The book does not set forth the "researches" of the writer, or, if doing so, makes little of them; it is a contribution to pedagogy, based on compiled materials of every kind. There is nothing of the artless art of Gilbert White, nor indeed (in spite of Selbornian imitators) is such a thing quite possible in this sophisticated age.

All things considered, Professor Thomson's book is a charming example of popular scientific writing, and we would recommend it to those who have some knowledge of the matters whereof it treats. The other day I took occasion to read one of the chapters (The Tale of Tadpoles) to a large university class in biology, and in so doing came to highly appreciate its merits, and at the same time notice what seemed to be its faults. It is extremely suggestive, so that all along the line one is tempted to interject new arguments and facts.

The whole book is just a little uncritical, the author having a field so wide that he can not quite master all the details, so that at times he takes little doubtful data on trust, and at others is perhaps led somewhat astray by his own rhetoric. This must be the fate of all popular writers and teachers, indeed of all university professors. As one of our most brilliant researchers and teachers put it in conversation recently, there is always this dilemma: if you make yourself quite clear and strive to be perfectly logical, you do it at the expense of some of the truth, because in dealing with biological matters you are never really free from difficulties and uncertainties. If you go to the other extreme, you merely produce confusion. Substantially, the method so excellently typified by Professor Thomson's writings is abundantly justified and sufficiently accurate, but critical readers will always wish that some things had been stated rather differently.

Another fault in the book reviewed is, I think, an undue tendency to use words which are not likely to be understood by the general reader. Even in the reading just mentioned, to a more or less instructed class, I found myself frequently translating. Against this objection must be set the undeniable fact that the author's rich vocabulary enables him to state things more accurately and briefly than would be possible were he to use only the poor English of the street.

There still remains the question whether popular science, as presented to-day by Professor Thomson and a number of other eminent men, has not swung too far away from the standpoint of Gilbert White. Is there not some danger of becoming too professional, too pedagogical? Is it too much to say that we can not have a real diffusion of culture in these matters until we have more of the spirit of the amateur?

The new edition of "Selborne" has a most attractive appearance. It is reprinted from the original without any alterations or annotations; there is not even an editorial note. The numerous colored plates are pleasing, yet I think not wholly satisfactory. In many the

outlines are too hard and the colors not quite true; there is too much of the mannerism of the artist. The colored plates in Professor Thomson's book also seem to me criticizable; they look a little out of focus, as it were—much as things look to the present writer when he has mislaid his glasses.

On the chance that some of our active workers in genetics have not recently read their "Selborne," it may be worth while to quote the following pertinent information: "One thing is very remarkable as to the sheep: from the westward till you get to the river Adur all the flocks have horns, and smooth white faces, and white legs; and a hornless sheep is rarely to be seen: but as soon as you pass that river eastward, and mount Beeding-hill, all the flocks at once become hornless, or, as they call them, poll-sheep; and have moreover black faces with a white tuft of wool on their foreheads, and speckled and spotted legs: so that you would think that the flocks of Laban were pasturing on one side of the stream, and the variegated breed of his son-in-law Jacob were cantoned along on the other. And this diversity holds good respectively on each side from the valley of Bramber and Beeding to the eastward, and westward all the whole length of the downs. If you talk with the shepherds on this subject, they tell you that the case has been so from time immemorial, and smile at your simplicity if you ask them whether the situation of these two different breeds might not be reversed. However, an intelligent friend of mine near Chichester is determined to try the experiment; and has this autumn [1773], at the hazard of being laughed at, introduced a parcel of black-faced hornless rams among his horned western ewes. The black-faced poll-sheep have the shortest legs and the finest wool."

T. D. A. COCKERELL

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THE HINDU-ARABIC NUMERALS

IN a recent number of SCIENCE¹ I ventured to assert the correctness of the statement that our present decimal place system with the zero

¹ January 5, 1912.

is of Hindu origin. The veteran historian of mathematics, Moritz Cantor, makes substantially the same assertion in the latest edition (1907) of the first volume of his "Vorlesungen über Geschichte der Mathematik," p. 608. He says, referring to the use of words with place value.²

This kind of conscious juggling with the notions of positional arithmetic together with the zero, is most easily explained in the home of these notions, which (home) for us is India and this we may affirm even if there is question of a second home. We mean if both notions were born in Babylon, of which there is great probability, and were carried over into India in a very undeveloped state.

We may add that neither Cantor nor any other has yet presented any historical evidence that these ideas were carried over to India from Babylon. Eneström, the editor of the *Bibliotheca Mathematica*, a journal devoted to the history of mathematics, has recently³ supported the view that the Babylonian arithmetic is not of the same nature as our system. The Babylonians did not use the zero, so far as we know, with the same notion of place value for purposes of computation as in the Hindu system. The Babylonian multiplication tables published by Hilprecht which include tables of 1,800 times various numbers are an evidence of this fact. In a fully developed sexagesimal (60) system this table would be replaced by the table of thirty times the corresponding numbers, since 1,800 equals 30 times the unit of higher order, 60. Furthermore, the Babylonian system was not adapted for computation because of the mixture of decimal and sexagesimal systems and further because of the large base, 60.

Recently another early document referring to the Hindu numerals has been published. This document is of prime importance because, being written in 662 A.D., it antedates by more than two centuries the earliest known appearance in the ninth century of the numerals in Europe. The probability is, too, that the

² See Smith-Karpinski, "The Hindu-Arabic Numerals," p. 39, for an explanation of this system.

³ *Bibliotheca Mathematica*, Vol. XI. (3), 1911, p. 331.

numerals were fully developed in India not much more than two centuries before this time. We are thus brought very close to the time of the origin of the powerful symbols which we use for computation. Further, the passage is of interest because it explicitly mentions the Babylonian contributions to astronomy and we must conclude that if the writer at that early date had known of any connection between the Babylonian number system and the Hindu he would have mentioned it. The passage in question is presented by M. F. Nau in some notes on Syrian astronomy.⁴ M. Nau quotes from the writings of one Severus Sebokt, bishop of the monastery at Quennesra, on the Euphrates, near Diarbekr. This Sebokt was famous in a literary way and made his monastery a center of Greek learning. He himself was originally from Nisibin towards India, and it is not beyond the bounds of probability that there he came into contact with the learning of the Hindus.

Sebokt claimed for the Syrians the invention of astronomy. He stated that the Greeks went to school to the Chaldeans of Babylonia and these, he adds, are Syrians. This statement of Sebokt's is supported by the most recent investigations in the history of the development of science. An interesting article on this subject was published by F. Cumont, entitled "Babylon und die griechische Astronomie."⁵ Sebokt concludes that science is not the peculiar property of the Greeks, but rather open to all men.

The subsequent passage contains the reference to the numerals and I translate from the French translation given by M. Nau:

I omit now to speak of the science of the Hindus, who are not Syrians, of their subtle discoveries in this science of astronomy—(discoveries) which are more ingenious than those of the Greeks and even of the Babylonians—and of the easy method of their calculations and of their computa-

tion which surpasses words. I mean that made with nine symbols. If those who believe that they have arrived at the limits of science because they speak Greek had known these things, they might perhaps have been persuaded, even though a little late, that there are others who know something, not only the Greeks, but even people of a different language.

LOUIS C. KARPINSKI

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SPECIAL ARTICLES

THE SOURCE OF THE CURRENT OF INJURY

WHEN we connect calomel electrodes filled with KCl solutions of the same concentration with the uninjured skin and an injured spot of an apple, respectively, we notice a potential difference from between 40 to 100 millivolts, the injured spot of the apple being negative to the uninjured spot. We have made experiments which indicate that the so-called current of injury is due to a difference of potential which exists on the inside of the skin of the apple probably at the limit between the skin and an adjacent layer of cells, the latter being negative to the former. The proof for this statement is found in the following facts.

1. When we form a cell of the type

$n/10$ KCl	| Apple |	$n/10$ KCl
uninjured		injured
side		side

the E.M.F. remains the same no matter how deep a hole we make into the apple. As soon, however, as the $n/10$ KCl approaches the inner surface of the apple the E.M.F. suddenly becomes smaller and finally disappears.

This is not due to an injury of the skin itself, since a change in the concentration on the outer surface of the skin still gives the same change in E.M.F. as in an intact apple. The disappearance of the "current of injury" when the salt solution reaches the inner surface of the membrane of the apple is therefore due to the disarrangement or destruction of a specific layer on the inside of the surface film of the apple.

2. By pressing the surface of an apple with a finger we can destroy the adjacent layer on the inside of the skin without injuring the

⁴ *Journal asiatique*, Vol. 16 (10th series), 1910, pp. 225-227.

⁵ *Neue Jahrbücher f. das klass. Altertum, Gesch. und deutsche Literatur und f. Pädagogik*, 1911, Vol. 27-28, pp. 1-10.

latter. This can again be proved by measuring the influence of the change of concentration of a salt solution on that outer surface, which is exactly the same as it was before the pressure was applied. If, however, we connect this part of the skin and an intact part of the skin with a pair of calomel electrodes filled with a KCl solution of the same concentration, we get an E.M.F. of the same order of magnitude and the same sign, as if the skin at the pressed spot had been removed. This experiment, which is very striking, indicates also that the current of injury is due to the existence of a potential difference at the inner surface of the skin of the apple which depends upon the integrity of a definite structure.

3. An attempt to account for the nature of this E.M.F. led to the discovery that salts and acid, if applied in the same concentration to the outside surface of an apple, give rise to differences of potential of the same order of magnitude as found in the current of injury. The E.M.F. of the cell

$$\begin{array}{l} n/10 \text{ NaCl} \mid \text{uninjured apple} \mid n/1,000 \text{ NaCl} \mid \\ \qquad \qquad \qquad n/10 \text{ NaCl} \quad \quad \quad \text{(I.)} \\ \text{is greater than that of the following cell} \\ n/10 \text{ NaCl} \mid \text{uninjured apple} \mid n/1,000 \text{ HCl} \mid \\ \qquad \qquad \qquad n/10 \text{ NaCl} \quad \quad \quad \text{(II.)} \end{array}$$

In (I.) the E.M.F. was .088 volt, in (II.) .038 volt.

4. Since this difference is of the order of magnitude of that found in the current of injury, it was natural to test the action of the juice pressed out of the apple. Its conductivity was found to be $K_{10} = .00226$. This would correspond to a concentration of $n/58$ if the electrolyte contained in the sap were KCl, or $n/170$ if it were HCl. The apple juice contains a considerable amount of malic acid. Nevertheless it does not have the negative effect characteristic of the acid. If the negative potential on the inside of the skin is due to a layer of acid it must differ in its action from the sap pressed out from the apple.

These experiments indicate that the current of injury of the apple is due to a potential difference at the inner limit of the skin or

membrane; and that this potential difference depends upon the integrity of a preformed structure. This structure may give rise to the formation of a film of an acid but this is hypothetical.

Our observations prove that Hermann's alteration theory of the current of injury can not be correct. This theory assumes that the difference of potential exists at the injured surface, while the experiments mentioned here show that the seat of the potential difference is, at least for the apple, not at the seat of the lesion, but at the inner limit of the intact skin or membrane and its intact adjacent layer. DuBois's preformation theory is confirmed, although in a different form from that which this author suggested.

JACQUES LOEB,
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SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 498th regular meeting of the society was held in the assembly hall of the Cosmos Club on April 13, 1912, with President Nelson in the chair.

Under the head of General Notes, Dr. B. W. Evermann exhibited dyed and undyed skins of fur seals from the Pribilof Islands, and made remarks on the commercial classification of skins and on the aims of the Bureau of Fisheries regarding the fur-seal industry.

The paper of the evening was by Mr. Chas. Sheldon on "Winter Animal Life about the Base of Mt. McKinley." Mr. Sheldon gave an interesting account of his experiences with the birds and mammals of the Mt. McKinley region during the winter of 1907-08, describing in detail the food and habits of the Alaska jays, the mallard ducks, which were found wintering where local conditions favored open water and sufficient food, the lynx, conies, foxes, caribou, moose and sheep. Mr. Sheldon's lecture was admirably illustrated with numerous lantern slides, showing his cabin, general and detailed views of the country and long- and short-range snap shots of all the larger animals of the region.

THE 499th regular meeting of the society was held in the assembly hall of the Cosmos Club on

April 27, 1912, with President Nelson in the chair.

Three papers were presented:

Are Rabbits Rodents? J. W. GIDLEY. (To appear in SCIENCE shortly.)

Remarks on the Skeleton of the Dinosaur, Stegosaurus: C. W. GILMORE.

The type specimen of *Stegosaurus stenops* Marsh in the U. S. National Museum is the most complete skeleton of the genus that has yet been discovered, and the recent assembling of the large blocks of sandstone which contain this fossil enabled Mr. Gilmore to discuss several points in its anatomy. Especially attention was given to the position and arrangement of the elements which comprise the dermal armor, and since this is the only individual known which gives anything like a true idea of the manner in which the armor was attached the importance of the specimen is at once apparent.

It was pointed out that there was a great diversity of opinion among vertebrate paleontologists, especially regarding the number and arrangement of the plates and spines constituting the exoskeleton. Marsh in 1891 made the first pictorial restoration of *Stegosaurus* and placed the series of flat plates (12 in number) in a single row along the median line of the neck, back and tail, with four pairs of spike-like spines near the end of the tail. Lucas in 1901 published the next restoration, and was the first to show the plates (28 in number) arranged in pairs. Later in a statement prepared under his direction the plates of opposite rows (22 in number) were made to alternate, and the spines were reduced from four to two pairs. The latest conception, as exemplified by a recently mounted skeleton in the Peabody Museum of Yale University, shows a return to the paired arrangement of the plates (28 in number) and the retention of four pairs of spines.

It was shown that specimens in the National Museum corroborated most conclusively Lucas's second interpretation, and with the exception of one or two points is entirely in accord with the evidence.

That the plates of opposite rows did alternate is shown by the way they lay embedded in the rock, and that no two of them were precisely similar in shape or dimensions.

It was demonstrated that the usual number of spike-like spines is two pairs, as shown by seven individuals, six of which are in the National Museum.

The facts relating to the dermal armor which now appear to be established from this preliminary study are:

1. That the armor of the neck, back and tail was found by two rows of erect plates, the elements of one row alternating with those of the other.

2. That the total number of plates in the two rows was not less than 22.

3. That the position of the largest plate of the series appears to be above the base of the tail, and not over the pelvis.

4. That the usual number of dermal spines on the tail is 4, arranged in two pairs.

Early Bird Migration in a Late Spring at Washington, D. C., 1912: WELLS W. COOKE.

The winter of 1911-12 was the coldest at Washington, D. C., for many years, and yet several species, notably the robin, were more common than usual, due to unusually warm weather in December.

January, February and March to the 27th were far below the normal, and yet about half of the species of birds that arrived during this period were earlier than their average date. When, however, these species were examined more carefully, it was found that those who arrived early were all species that occasionally winter as far north as Washington, and these early migrants undoubtedly represent individuals that had spent the winter in the heavily forested swamps and had been observed when they returned to open country.

The rest of the species that arrived late during this cold period were all birds that winter far to the south of Washington.

On March 28 the weather turned warm and remained above normal for a whole month. Immediately birds began to arrive from the far south that were decidedly ahead of their normal date, and in the case of some of them, earlier than the earliest previous date. This is one of the best examples of what usually happens when a cold spell begins to break. The cold had been widespread, holding the birds far south, and when the warm spell began the birds rushed north and continued their flight longer than usual until they were actually ahead of their schedule time.

Almost every species for the whole of the rest of the migratory season of 1912 at Washington, D. C., arrived earlier than their average dates.

M. W. LYON, JR.,

Recording Secretary, pro tem.

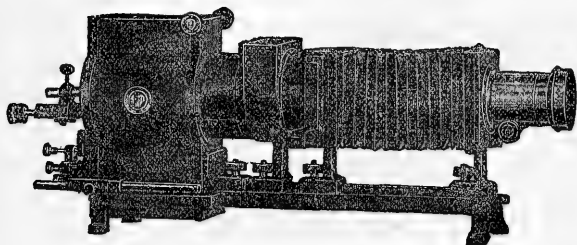
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SCIENCE

FRIDAY, JUNE 28, 1912

THE OPPORTUNITY OF THE ENDOWED
UNIVERSITY

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At first glance there would seem to be opportunity, in this country, for more than one type of college and university, and if the opportunity, then the obligation and the inspiration. Historically there are two types, but under identical environmental influences they present to-day few distinguishing characters. They exhibit a phenomenon very rare and interesting in biology. While we have been speculating and searching about the origin of species by evolution, the history of the American colleges has recorded the almost complete disappearance of a species through imitation, a transmutation instead of a mutation! The endowed college, later called university, was the first type to appear on the American continent; but with the growth of the public school idea, with the outgrowth of those aristocratic remnants which the early settlers so unconsciously brought with them and so strongly exhibited, and with the immense addition to the English stock by immigration from continental Europe with its universities founded and maintained by the funds of the people, it was only natural that state universities should come into existence. For the most part they are found in those states which have nothing more tangible to connect them with the past than *traditions* of aristocracy, and at all events they prosper most, if one may judge by our usual American standards of dollars or of numbers, in the states in which the people is most thoroughly satisfied that the people can do no wrong. The future, the opportunity, of the endowed university may appear, therefore, to

be anything but bright and inspiring; but an honest examination of the circumstances of the state and the endowed universities will lead any one to rejoice in the prospects of both.

The state university is endowed with the wealth of the state; its endowment increases with the wealth of the state, automatically and without struggle. What this has already meant in certain instances is but a small fraction of what the future has in store. The wealth of the richest of the colleges of Oxford and Cambridge is poverty in comparison with the potential wealth of some of our state universities: unless and until the descendants of the people which called the university into being recall it to a condition of penury. The endowments of the state universities yield incomes the large totals of which are increased at intervals by appropriations for such specific purposes as have won popular or legislative appreciation and approval or may capture the fancy of the self-styled "practical man."

The contrast of the endowed university with all of this seeming prosperity would be disheartening to its friends if they took no account of the influence of the endowment and income. While the income of the state university may grow proportionally with its endowment, its officers and friends take nothing for granted and occupy themselves in securing this happy result. On the other hand, once sufficiently endowed to be useful, the endowed university need not struggle for money. It will never have too much if it wisely spend what it has; and if it transmutes its gold into lives of exceptional usefulness, more gold will come to it from grateful alumni and from admiring friends who would increase its opportunities for service. The endowed universities have struggled for money as desperately as those of the states, but this has

been either because they were insufficiently endowed or because their administrations, not content with usefulness, lusted after bigness also. But given a sufficient endowment, so managed that its income will be both fair and uniform, the endowed university is independent as no state university ever is: not free from duties, but free from hindrances.

What the people wants, what it pays for, it rightly insists upon having. The people goes further and says that these things all the citizens of the state should have. The people insists above all upon training for practical life. To the schools of law and of medicine, agriculture and engineering, it enthusiastically and optimistically adds courses in domestic science, poultry husbandry, cheese-making, and the rest. Has it occurred to the "practical" legislator or the "practical" voter that the establishment of courses in domestic science has been followed by a more acute stage of the servant question? Is this mere coincidence?

The people demands of its university that it be in every way useful, that, where training is impossible, at least it should give information. In response to this demand come university extension (not university elevation), summer schools, farmers' institutes, short courses and correspondence. The young American democracies provide not only a "royal road to learning," but omnibuses traveling rapidly over the road with pneumatic tires—I forbear to mention the temperature of the air which fills them. These omnibuses always take in and discharge their passengers in haste and confusion, sometimes even in darkness. They must be driven by persons capable and sometimes desirous of taking a more promising company over a less commonplace road, whence the views, forward

and perhaps even upward, may be more extended.

As part of the educational system of the state, the state university must admit all presenting a high school diploma. It can not sift, and exclude the ignorant, for there is none ignorant, as the certificates show! It can not insist that the boy who would be an engineer present himself with a usable knowledge of algebra and geometry. It is obliged to accept as a working basis the popular delusion that all subjects furnish equally good preparation for college as well as for everything else, that all study is equally informing and developing, that all students are equally fit. But in so doing, in its seeming liberality in keeping its front door apparently so wide open, it places obstacles in the way of all who would enter from any other than the conventional school. The seriousness of these obstacles is seldom apprehended by others than those who encounter them. The boy whose family has traveled, taking him with them—the son of an engineer, or a missionary of commerce or religion, for example—having attended an accredited school for too short a time to receive a certificate, or being taught in a private school or in still more private lessons quite unknown to a registrar's office, finds himself unable to enter the wide open front door of the usual college, state or endowed. Although very likely more mature and better trained, of wider as well as more definite or first-hand knowledge, of broader experience and more independent thought, he is refused admission unless, by passing examinations to which only he and his kind are subjected, he convinces the authorities that he knows almost as much as a boy from the Bean Blossom High School in Posey County.

The state universities are more or less compelled to take the products of the public schools unsifted; they can not especially

cultivate and encourage the exceptional young person; they must do mainly a wholesale business; and they are increasingly burdened with great numbers of conventionally trained mediocrities. They are necessarily organized to receive, care for, graduate and find positions for these. Thus they annually produce more teachers who will produce more students of the same mediocre sort. What this weight of numbers is may be indicated by the attendance, in round numbers, on the usual elementary course in botany at the following universities:

Wisconsin	300
Minnesota	500
Nebraska	350
Stanford	50

Botany I. at Harvard, a fairly large course (130), is not the equivalent of Botany I. at the universities above mentioned, and the corresponding course has between 40 and 50 in it. Granting the stimulation of lecturing to large numbers, what is the effect of attempting laboratory work for so many? Providing, in the winter, plant material for such numbers, organizing and directing the staff of assistants, conferring with students in this and in the more advanced courses, the head of the department and his colleagues find their time, their strength, and finally their desire, for their own researches exhausted. There is no time for reflection; every one is so busy doing that there is no opportunity for thinking; every one is working at high pressure, but is it worth while? Researches come from these laboratories, but they are not original. They are the products of the changing fashions rather than the fruit of individual effort. A glance at the programs of the national scientific societies proves that isotonic coefficients and chromosomes have been displaced by mutation, Mendelism, and plant-breeding. American

universities add annually to the "literature" of science, and in the great numbers of elementary students to be cared for I think we can all see one great reason why the contributions of promising American scientific men have reached no higher level.

Turning now to the endowed university, it is obvious that its officers need spend no time at the capitol, for its income can not there be increased; they need make no concessions in order to keep Greek from disappearing from the catalogue; they can let others wrestle with the problems of "educational psychology," "humanities" and "live stock practise" while devoting themselves to psychology, sociology and zoology. The endowed university may go its own way independent of the currents of fashion and of popular whim. It is naturally sheltered from those influences. It is only when its leaders attempt to duplicate the work of the state university that it finds itself exposed to the same influences. And when it exposes itself to these influences, it does so without the defenses of the state university.

The opportunity of the endowed university is a great one, inspiring to contemplate. It, or its *directing* administration, may determine its course, select the subjects it will teach, specialize instead of generalize, foster pure science and the arts. Whether American universities be democracies or autocracies, all or some of the officers of the endowed universities have the opportunity, and the obligation, to decide what these universities will do—whether to compete on unequal terms of wealth and of other forms of support with the state universities, to seek numbers, to strive for bigness, to submit to the fashion, to comply with the current wish: or to decide what it will attempt, what subjects it will cultivate, to teach and to investigate and to develop these to a degree unequalled else-

where; to pursue the studies of pure science, the humanities and the arts as assiduously and as devotedly as if they were themselves the keys to wealth.

The endowed universities may select their students on any basis that they will; may pick the children of the well-to-do or young people whose unprogressive parents have cruelly limited them to schooling in Latin, Greek and mathematics when they might have "taken" hygiene, civics and "vocational subjects"; may, on the other hand, welcome the exceptional as well as admitting the usual; may cultivate and encourage the best. The endowed university may as consciously and as definitely prepare for the few, for the unusual, the most original and the most stimulating student as the state university must certainly prepare for unsifted numbers.

The masses of a democracy recognize present wants more surely than they anticipate future needs. They require an immediate supply to meet an existing demand. They consider their state university to be well fulfilling its functions when it furnishes such a supply. How well it succeeds in this the fair-minded observer admiringly acknowledges. But the wholesale business of the state university limits, if it does not practically prevent, that attention to the exceptional student which may result in training a leader of his generation, a seer who, divining the future needs of the state, may begin to prepare to meet them, a man who, profiting by the recorded experience of the past, may mold as well as meet conditions. The training of workers is the duty of the state and of the endowed university; the training of leaders is the privilege more especially of the endowed universities for the reasons I have given. How well some of the endowed universities have apprehended and lived up to this privilege the records of

Harvard and Yale, of Columbia and Princeton, and of Johns Hopkins *sui generis*, fully attest. May they not neglect their privilege and abandon their peculiar work!

What the endowed universities have successfully and naturally done for generations some of the state universities are now attempting against opposition of every sort. How successful, judging only by the test of quality, not of numbers, these universities will be in producing statesmen, jurists, economists and explorers in the fields of pure science, it is still too early to say. To recognize these in embryo, to train these young people for their distinctive careers, is easier for the endowed university than for that of the state, provided only that the endowed university, realizing its privilege and confining its efforts to its special field, does its duty. This, I take it, is the special service which the endowed university can perform, its reason for existence by the side of the university of the state, not copying it, not competing with it, but supplementing it, training leaders.

Their numbers, their courses, limited by their incomes, the endowed universities may remain small with no sense of shame or of failure. The Rookwood Pottery is smaller than many a brick-yard, yet all are needed, all are useful. In the space and quiet of "the yard" or of the quadrangle there is time for reflection, for review, which in the past have led to real contributions to knowledge or to thought. The scholar's life and the scholar's product, not fostered by the conditions of office or consulting-room, may continue if the endowed universities recognize and cherish their high privilege, serving the state and the world with their own peculiar talent, not copying the form or attempting the task of their huge neighbors, not seeing in them rivals but friends. May these allies, real-

izing their privileges, their distinctive opportunities, win the glories of their recognized usefulnesses!

GEORGE J. PEIRCE

LELAND STANFORD JUNIOR UNIVERSITY

RESEARCH ON THE SMOKE PROBLEM AT
THE DEPARTMENT OF INDUSTRIAL
RESEARCH OF THE UNIVERSITY
OF PITTSBURGH

SMOKE exists to a greater or less extent in every city where soft coal is burned. The world at large has not, up to the past few years, regarded it as a waste. It has been considered synonymous with prosperity. Its right to cloud the heavens has been traditional. The enormity of this evil is fast being forced upon the public attention so that the manner in which it is being combated in the big metropolitan centers affords an interesting and profitable subject for study.

Strange to relate, when one stops to consider the breadth of interest and importance of this problem, together with the fact that so many thousands have worked on its various phases, and that so much has been written and is being written on the subject, still no co-ordinated effort of one group of men has been made to undertake a scientific study of the problem as a whole. One of Pittsburgh's most public-spirited citizens, a man devoted to the city's welfare, recognizing this fact, has established a fellowship of \$12,000 per year with the department of industrial research of the University of Pittsburgh for the scientific investigation of this problem.

We have an unpretentious laboratory, designated as the "smoke house," a small, fireproof building, 18 feet wide and 30 feet long, which is situated at a sufficient distance from the main laboratory, so that the smoke in quantities as great as we may need in our work can be made without interfering with the other researches being carried on. In this building there is a furnace, so constructed that it is possible, by varying conditions, to get any kind of coal smoke. This statement may, perhaps, appear peculiar to those who have always considered smoke as just smoke, but our studies

of this subject reveal new properties continually. There are differences in the physical state as well as in the amounts of tar, carbon, ash, etc., in smoke made from different kinds of coal under different conditions of temperature, etc. By means of fans and motors, the smoke can be conducted to various parts of the building, where it can be used for experimental purposes in any manner desired. It is here that the physical and chemical studies are being conducted with the object of learning more definitely just what the various properties of soft coal smoke are, and endeavoring to ascertain new properties which will be of aid in the abolition of the smoke itself.

It is a well-known fact that it is possible to prevent smoke with the accompanying economy of fuel and that there are many forms of furnaces constructed which can be operated with ideal results. The obtaining of men sufficiently intelligent for their proper operation is, however, a problem difficult of solution, for the wages are small and employment far from pleasant. One of the chief aims of our experimental work is, then, to find a means of making the man in the boiler room perform his duty in the best possible manner. A mechanism is being devised, which is simple, practical and "fool-proof," that will automatically warn the stoker in the boiler room that the smoke his fire is making is in excess of the law.

Inquiry is being instituted, in the most accurate manner possible, into the true increase in the cost of living due to the damage done by smoke to the property of the residents of this smoky district. Special stress will be laid upon this portion of the investigation because of the fact that while those who have made Pittsburgh smoky may be large losers by the neglect, they are in all probability not the greatest. Among the list of sufferers upon which the burden falls, we may include dwellings, hotels, hospitals, picture galleries, museums, office buildings, banks, libraries and stores, both wholesale and retail.

The relation of smoke to the health of the residents of a smoky district is one worthy of careful consideration, and one which we hope

to be able to put on a more scientific basis than the present.

It is a well-known fact that the lungs of a person dwelling in a smoky atmosphere become coated with soot particles. Does this make him more susceptible to consumption? The question has been answered both negatively and positively by different authorities. From a thorough examination it would appear that Pittsburgh did not have as much consumption as other cities similarly located, where there is much less smoke. Within the corporate limits of the city there is more consumption in the better residence portions, where there is less smoke and dirt than in the more congested district where smoke abounds. On the other hand, catarrh, pneumonia and other so-called "bad air" diseases are very prevalent, due to the irritation caused by the smoke particles. Furthermore, it has been said by some that because of the mucus swallowed in these diseases, stomach trouble is thus indirectly caused by smoke. The eyes are not immune, either. Eye specialists say that the busiest time is after a heavy fog accompanied by smoke.

From the side of aesthetics and the city beautiful, we must take up the effect of coal smoke on buildings and on plants. The botanical side of the question is one of special scientific interest, for while the relation of plants to smelter fumes, etc., has received considerable attention, little if anything seems to have been accomplished or even attempted from the standpoint of the carbon with the accompanying tar-containing phenol and other compounds of a similar nature. It may be of interest to state in this connection that I have found as high as 44 per cent. tar in samples of soot examined. Knowing this, it can well be understood that carbon smoke might have a very injurious effect on vegetation, more especially in spring, when the new leaves are appearing and things being tender are much more readily affected by the toxic action of the soot and accompanying substances.

The meteorological aspect of the smoke problem is being considered. This part of the investigation will, for the greater part, consist

of the application to our local conditions of the methods used in other places.

The smoke problem is not an easy one to handle. There are many obstacles to overcome and many prejudices to set right. Without power to act, knowledge in itself would be of little avail. Therefore the legal aspect of the situation will form no small part of our investigation.

In brief, then, we have in this research the twofold object of scientifically ascertaining the true economic status of the smoke problem in all its phases and the devising of ways and means of making the smokeless combustion of soft coal the rule rather than the exception.

R. C. BENNER

UNIVERSITY OF PITTSBURGH

CANCER RESEARCH

DURING the past winter important developments in the field of cancer research have occurred in New York City which have hitherto escaped public notice. By the addition of \$100,000 to the endowment fund of the General Memorial Hospital to be used for the maintenance of 20 free beds for cancer patients, a well-known scientific man has provided the staff of the Collis P. Huntington Fund for Cancer Research with greatly increased facility for the study and treatment of cancer in the human being.

The General Memorial Hospital for the Treatment of Cancer and Allied Diseases was originally chartered for the study and treatment of cancer but at the time of its foundation, cancer had little interest to any one but the surgeon. To-day the wide field of research opened up by the experimental study of cancer is too costly to be undertaken by any hospital without an unusually liberal endowment; and it may be said that no hospital in New York possesses to-day an adequate endowment for this purpose.

The General Memorial Hospital has enjoyed the support of the Huntington Fund for Cancer Research founded by Mrs. C. P. Huntington, since 1902. The trustees of this fund, of which the late Dr. W. T. Bull was chairman, placed the fund at the disposal of

Cornell University Medical College in whose laboratories systematic research has been conducted as far as the income of the fund and the resources of the university would permit. Under this arrangement three volumes of studies have been published relating chiefly to experimental observations on lower animals, but the work has been limited in scope by the lack of hospital facilities, and a close cooperation between the laboratories and the hospital wards.

The recent donor, himself a scientist of international reputation, a supporter of cancer research, both here and abroad, and fully acquainted with the proper organization of such work, determined to supply the needs of the Huntington-Cornell staff, and by his liberal-ity has opened a portion of the General Memorial Hospital to cancer research under very favorable auspices. In addition to the endowment of 20 beds, chemical and pathological laboratories are now being constructed in the hospital and a complete X-ray and Radium department is being provided for the early diagnosis and treatment of the disease.

This latest addition to the resources of cancer research is significant in several respects. It is a noteworthy instance of the discriminating support of science by a scientific man who knows exactly what his gift may accomplish. It supplies for the first time in New York City the opportunity for men trained by a university in many branches of medical science to study this disease at the bedside. It enables the pioneer institution founded in the city for the care of malignant disease at last to enter in earnest into the field for which it was established. Incidentally it points out a way for a most effective use of much larger endowments than are even now available. Although a considerable capital is represented in the various branches of this institution, clinical cancer research has been found to be extremely costly, and even the present endowment fails to provide all the important necessities in the work.

Not the least gratifying result is that New York City is now provided with an institution similar to those recently established in

London, Berlin, Heidelberg and Paris, abroad, as well as in Buffalo, St. Louis and Boston, here, and that this institution has the advantage of having an organization of men thoroughly trained in cancer research work, which it has taken ten years to develop and bring together.

The problem of cancer is the most serious of all the problems that confront the medical profession to-day. The steady increase of the disease baffling all efforts to discover the cause or a means of controlling it has attracted the leading minds in medicine to the field of cancer research. The only hope of a solution of this great problem is by bringing to bear upon the problem, the combined efforts of every department of medical science and by having the closest affiliation between the cancer wards and the scientific laboratories of a great university. W. B. C.

THE NATIONAL ARGENTINE OBSERVATORY

UPON the recommendation of the Minister of Public Instruction the Argentine Congress has provided in its budget for 1912 a 5 foot reflecting telescope for the National Observatory at Córdoba.

It is expected to locate this telescope in the mountains to the west of and close to Córdoba where preliminary investigations have already been made and the meteorological conditions found to be good.

The program of work for this telescope comprises photographs and other investigations of the nebulae and clusters of the southern sky, in continuation of similar work in the northern sky; photographic observations of comets, faint satellites, etc.; stellar parallax; observations of special regions of the sky; spectrographic observations with high and low dispersion and in the line of sight.

C. D. PERRINE

OBSERVATORIO NACIONAL ARGENTINO,
CÓRDOBA, May 11, 1912

AN INTERNATIONAL CONGRESS OF ANTHROPOLOGY

AT an International Conference called by the Royal Anthropological Institute and held

June 4 in the rooms of the institute, London, immediately following the sessions of the International Congress of Americanists, it was voted to organize an international congress of the anthropological sciences, which shall either include several existing congresses or work in affiliation with them. The congresses which it is hoped may become a part of the projected congress are Congrès International d'Anthropologie et d'Archéologie Préhistoriques, International Congress of Anthropology, Congrès Internationaux d'Ethnographie, International Folk-Lore Congresses and International Congress of Americanists. The organizing committee appointed by Dr. A. P. Maudslay, president of the conference, consists of the following: Maudslay (*ex officio*), chairman, R. R. Marrett (Oxford), secretary, Hrdlička, Boas, Krämer, Capitan, Heger, Duckworth, Waxweiler, Lafone Quevedo, van Panhuys. This committee met at the close of the conference and decided that a congress should not be held before 1915 (if then). In the meantime a general committee is being constituted by gradually adding names to the organizing committee; and sub-committees are being formed to establish harmonious relations with the various existing international congresses.

GEORGE GRANT MACCURDY

HONORARY DEGREES IN SCIENCE

THE degrees conferred by Harvard University at its recent commencement on men of science and words used by President Lowell are as follows:

Master of arts: Charles Francis Stokes, surgeon for sailors in peace and war, on sea and land, on battleships in the west and the east and around the world; professor of surgery, director of hospitals, Surgeon-General of the Navy. Doctor of science: Frederick Forchheimer, who in his practise, by his teaching, and with his pen, has contributed to the marvellous advance of medicine in our day; a man in the judgment of his peers worthy to preside over the Association of American Physicians; Carlos de la Torre y Huerta, statesman and naturalist; first in his knowledge of the molluscs of the Gulf; discoverer of fossils who has revolutionized the geologic history of Cuba; Frederick Cheever Shattuck, a teacher of medicine, pungent

and incisive; a practitioner with the insight that makes a physician great, and with a strong man's sympathy that has brought comfort and courage to countless sufferers; Benjamin Osgood Peirce, physicist and mathematician, by whose skill in experiment and calculation intricate problems in heat and magnetism have been solved; a man of science ignorant only of his own deserts. Doctor of laws: George Washington Goethals, a soldier who has set a standard for the conduct of civic works; an administrator who has maintained security and order among a multitude of workmen in the tropics; an engineer who is completing the vast design of uniting two oceans through a peak in Darien.

The honorary degree of doctor of laws was conferred by Western Reserve University, at commencement, upon Dr. P. P. Claxton, United States Commissioner of Education; Dr. G. A. Gordon, pastor of the Old South Church, Boston, and Dr. T. C. Mendenhall. Dr. Mendenhall was presented by Dr. Frank Perkins Whitman, professor of physics, who said:

Mr. President: I present to you, that he may receive at your hands the degree of doctor of laws, Thomas Corwin Mendenhall, teacher, investigator, administrator, professor of physics, but chiefly leader and inspirer of youth in this state, and the Imperial University of Japan; effective interpreter of nature and her laws; president of two notable scientific schools; head of a great government department; leader or collaborator in many scientific undertakings of the United States. Though prevented in youth by circumstances, not according to his desire, from entering regularly on her courses of study, Professor Mendenhall is no stranger to Western Reserve, for at the old college in Hudson he found a congenial academic atmosphere, and the inspiration of high scholarly ideals, as a special student with Professor Charles A. Young. To-day Western Reserve University cordially receives him into the company of her graduates, at the summit of a career of which in the day of small beginnings she is happy to have had some part in laying the foundation.

Among recipients of the doctorate of laws from the University of Pennsylvania are the following: Joseph Swain, president of Swarthmore College, and the orator of the day; Louis A. Duhring, professor emeritus of dermatol-

ogy and honorary curator of the dermatological collections of the University of Pennsylvania; James Tyson, emeritus professor of medicine at the University of Pennsylvania, and John Grier Hibben, president of Princeton University.

At its recent commencement Northwestern University conferred the degree of doctor of science on Dr. Henry Smith Carhart, emeritus professor in the University of Michigan and from 1872 to 1886 professor of physics in Northwestern University.

Brown University has conferred the honorary degree of doctor of science on Professor W. J. Hussey, director of the observatory of the University of Michigan.

SCIENTIFIC NOTES AND NEWS

The board of scientific directors of the Rockefeller Institute for Medical Research announces the following appointments and promotions: Alexis Carrel (experimental surgery) has been promoted to the rank of member of the institute. The following associates have been made associate members for a term of three years: Peyton Rous (pathology and bacteriology), Donald Dexter Van Slyke (chemistry), Walter Abraham Jacobs (chemistry) and Frank Watts Bancroft (experimental biology). The following assistants have been made associates: Paul Franklin Clark (pathology and bacteriology), Richard Vanderhorst Lamar (pathology and bacteriology) and Harold Wasteneys (experimental biology). The following new appointments are announced: Harold Lindsay Amoss (assistant in pathology), Clarence J. West (assistant in chemistry), Wolfgang Ewald (fellow in experimental biology), Francis Richard Fraser (assistant resident physician and assistant in medicine), Frederic Moir Hanes (assistant resident physician and assistant in medicine).

DR. EDGAR W. OLIVE, professor of botany in the State College of South Dakota, and state botanist, has been appointed curator in the Brooklyn Botanic Garden, to have charge of the department of public instruction, and also

of the work in plant pathology. The appointment takes effect on September 1, 1912.

CAPTAIN H. G. LYONS, F.R.S., has been appointed assistant director of the Science Museum, South Kensington.

PROFESSOR DÜRCK, until a short time ago director of the pathologic institute at Jena, has assumed the direction of the pathologic institute at Rio de Janeiro.

THE executive committee of the Entomological Society of America has named the following as additional delegates to the second International Congress of Entomology, to be held at Oxford, England, August 5 to 10, 1912: Professor Stephen A. Forbes, University of Illinois; Dr. L. O. Howard, chief, U. S. Bureau of Entomology; Dr. Wm. M. Wheeler, Harvard University; Dr. James G. Needham, Cornell University.

THE former students of Professor O. Henrici, F.R.S., who recently retired from the chair of mathematics at the City and Guilds Engineering College, have had engraved in his honor a medal to be awarded annually for proficiency in mathematics.

THE alumni and students of the School of Mines of the University of Pittsburgh have held a banquet in honor of Professor M. E. Wadsworth, the retiring dean of the school. In presenting a silver loving cup to him, Mr. Floyd Rose said: "In the four years during which Dr. Wadsworth has been with us he has become intimately associated with every student in the school. He has aided the weak, encouraged the despondent and won the affection of every one with whom he has come in contact. A more popular or more successful dean the university has never seen. From an insignificant department, he has developed the school of mines into one of the best schools of its kind in the country. It is a source of pleasure that, though he retires from teaching, he will remain with us as dean emeritus."

THE Lucy Wharton Drexel medal of the Museum of Archeology of the University of Pennsylvania has been awarded to Dr. M. Aurel Stein for his explorations in China.

THE Albert medal of the Royal Society of Arts has been awarded to the Right Hon. Lord Strathcona and Mount Royal, F.R.S., for his services in improving the railway communications, developing the resources and promoting the commerce and industry of Canada and other parts of the British empire.

DR. CHARLES J. CHAMBERLAIN, of the University of Chicago, has been elected an honorary member of the Naturforschende Gesellschaft an der Kaiserl. Universität zu Kiew, Russia. Dr. Chamberlain has just returned from Australia and South Africa, where he has been making a field study of the oriental cycads and collecting material for a detailed morphological investigation.

PROFESSOR BURTON E. LIVINGSTON is continuing his researches at the Desert Laboratory during the present summer. He is assisted by Mr. E. M. Harvey.

MR. J. T. LLOYD, assistant in limnology in Cornell University, has recently gone from Colombia, where he has been spending the past six months collecting in the summits of the Andes, to Europe, where he will spend the summer visiting fresh-water biological field stations.

HENRY HOLMES BELFIELD, dean of the technological course of the high school of the University of Chicago from 1903 to 1908, and organizer of the Chicago manual training school, of which he was director until it was merged with the university high school in 1903, died in Ann Arbor, Mich., on June 5.

THE United States Civil Service Commission announces an examination on July 24, to fill vacancies in the position of entomological assistant (male), at salaries ranging from \$1,400 to \$1,800 per annum, in the Bureau of Entomology, Department of Agriculture, Washington, D. C.

A RESEARCH laboratory is being planned for the National Jewish Hospital for Consumptives at Denver, to cost about \$100,000.

THE nineteenth International Congress of Americanists to be held in 1914 will consist

of two sessions: the first in Washington, D. C., and the second at La Paz, Bolivia.

THE Paris correspondent of the *Journal of the American Medical Association* writes that the *Journal Officiel* has recently published very discouraging statistics on the French population in 1911. In 1911, there was an excess of 34,869 deaths while the year before there was an excess of 71,418 births. This difference is due, on one side, to the diminution of births (742,114 infants reported living in 1911 against 774,390 in 1910) and, on the other side, to the increase in the number of deaths (74,011 greater in 1911 than in 1910). The deaths have been more numerous in 1911 than in 1910 in almost all the departments. In proportion to the population, the Norman departments, as in the preceding years, furnished the greatest mortality. The notable increase in the proportional number of deaths in France as compared with many other countries is because France is one of the countries in which there are the greatest number of aged people and chiefly because of the small birth-rate of recent years. Although the birth-rate is low, France is among the countries in which the number of marriages is relatively large. In 1911, 307,788 marriages were registered. The constantly increasing number of divorces reached 13,058, slightly more than in 1910. The birth-rate is low in many countries at the present time, but in no country is it so low as in France. Among the many measures suggested to check this increasing depopulation, the most recent is the proposal which M. Messimy, former minister of war, has made to the bureau of the chamber of deputies. M. Messimy believes that a premium at the birth of every child born of the same mother, reckoning from the fourth, would increase the number of births. This premium would be \$100 (500 francs), of which one half would be paid to the mother at the birth of the child and the other half deposited in the national pay-office for pensions, in order to insure her an income from it during life. The mother could, however, collect the sum at once, or devote it to assure herself a

subsequent pension, which, in this case, would naturally be much greater. In order to meet the expenses which the premium of 500 francs or subsequent annual income would involve, M. Messimy proposes either to resort, entirely or partially, to the regular budget-resources or to place a special tax on bachelors as well as on heads of families without children or having only one child.

A CIRCULAR by the National Bureau of Standards, Department of Commerce and Labor, on the measurements of length and area, including thermal expansion, is in press. It supersedes a similar circular issued July 1, 1909. The new regulations and fees will go into effect May 1. The bureau gives notice that it will be glad to cooperate with investigators, manufacturers and others, not only in executing tests of the highest precision, but also, on request, in furnishing any information at its disposal concerning methods of measurement, the relations among and the legal status of units, the requirements that accurate standards should fulfill, and the design and construction of special apparatus. The bureau will not accept for tests standards and apparatus likely to change excessively or that can be checked with ordinary facilities, such as poorly divided scales or scales graduated on wood, celluloid or paper. A certain minimum of quality will be insisted upon to admit to test. The circular defines the conditions influencing the dimensions of bodies and also describes the fundamental unit of length. It refers to the interrelation of secondary and special units of length and area, with tables of equivalents added, and also devotes some space to a description of national prototype meters, of which it has accurate copies. For the routine work of testing use is made of secondary or working standards whose values are carefully determined by comparison with the bureau's prototype meter from time to time to detect any possible changes. These working standards include multiples and submultiples of the meter and of the yard. Methods of comparison of length standards are outlined and the classification

and nature of tests are defined. The circular concludes with general instructions to applicants for tests and gives the schedule of fees for reference standards, working standards, commercial standards, metal tapes, contact standards, precision screws and calipers, areas and area measuring instruments and thermal expansion of materials. For educational and scientific institutions and societies a discount of 50 per cent. will be allowed on all tests under the schedules stated.

UNIVERSITY AND EDUCATIONAL NEWS

SIR JULIUS WERNHER bequeathed £250,000 to the treasurer of the Union of South Africa for the purpose of assisting in building, and, if sufficient, partly endowing, a university at Groote Schuur, near Cape Town, and £100,000 to the Imperial College of Science and Technology, South Kensington, together with twelfth parts of his residuary estate, but not exceeding £50,000.

PROFESSOR NEWTON H. WINCHELL, of Minneapolis, for many years state geologist of the Minnesota Geological and Natural History Survey, has presented his geological library to the University of Minnesota. This library is probably one of the best private collections of geological literature in this country and was built up through the years when Professor Winchell, as editor of the *American Geologist*, had unusual opportunities for obtaining the earlier serial and regional reports of this and foreign countries. Many of its volumes are priceless. The library is now being installed in the department of geology at the University of Minnesota and will be known as the "Winchell Library of Geology," to which hereafter donations and exchanges should be addressed.

DR. EUGENE L. OPIE, professor of pathology in Washington University, has been appointed dean of the medical school to succeed Dr. George Dock, relieved of this duty at his own request.

SAMUEL N. SPRING, forester of Connecticut and lecturer in the Yale Forest School, has been appointed professor of forestry in the

New York State College of Agriculture, Cornell University.

DR. J. W. JENKS, professor of political economy at Cornell University since 1891, will become professor of government and public administration and director of political studies in the School of Commerce, Accounts and Finance of New York University.

DEAN WALTER R. CRANE, of the School of Mines, Pennsylvania State College, has been granted a year's leave of absence and left June 13 to spend the coming year in the study of the coal fields of Alaska and the northwest. Dr. Elwood S. Moore, professor of geology, will be acting dean during Dr. Crane's absence. Assistant Professor Thomas C. Brown, department of geology, has resigned to accept a similar position at Bryn Mawr College. Mr. H. N. Eaton, instructor in geology and petrography, University of Pittsburgh, has been appointed to succeed him. Associate Professor of Mining William M. Weigel has resigned to accept the position of general superintendent of the North American Smelting Company, Ltd., Kingston, Ontario, Canada. Hugh D. Pallister, instructor in metallurgy, has been appointed to succeed Professor Weigel with the title of assistant professor of mining. Harry B. Northrup and William A. Royce have been promoted from assistants to instructors in mining. Carroll A. Garner has been appointed instructor in mining.

The following appointments have been made for the coming year in the North Carolina College of Agriculture and Mechanic Arts: instructor in chemistry, J. W. Nowell, A.B. (Wake Forest), Ph.D. (Hopkins), and F. B. Sherwood, B.S. (North Carolina College).

At the Indiana University the following promotions from assistant professorships to associate professorships have been made: Robert D. Carmichael, in mathematics; Melvin E. Haggerty, in psychology; Clarence E. May and Frank C. Mathers, in chemistry; Fernandus Payne, in zoology.

DR. DANIEL STARCH has been promoted to the rank of assistant professor of psychology at the University of Wisconsin.

DR. JOHN SATTERLY has been appointed lecturer in physics at the University of Toronto.

MISS CARRIE M. DERICK, who has been acting-head of the department of botany at McGill University, Montreal, for two years, has been appointed professor of morphological botany. She is the first woman who has been made a full professor in a Canadian university.

DISCUSSION AND CORRESPONDENCE

OBLIQUE ORIENTATION OF MAPS AND HALF-TONES

It is a well-nigh universal custom of cartographers, in constructing maps on the orthogonal, conic, or any other projection with converging meridians, to draw the central meridian straight in each case and place it parallel to the lateral edges of the paper, except when dealing with small areas considerably elongated in a direction oblique to the meridians, such as Manhattan Island or some portions of the coast. In recent years, however, there have appeared in scientific literature quite a number of sketch-maps of the eastern United States with the central meridian inclined several degrees to the perpendicular, without any apology or explanation. One of the latest examples is the map of the chestnut-bark disease on page 420 of *SCIENCE* for March 15, 1912.

Evidently the persons who have submitted such maps for publication simply took base-maps of the whole United States and cut them parallel to the edges without taking the trouble to orient them in accordance with the cartographic principle above mentioned, and the result is rather offensive to the eye of the geographer. In the case mentioned less than half the original base-map was used, with the result that even the western edge of the published map is inclined a little to the left, and the central meridian is about 10° out of plumb. (There is a correctly oriented map on page 406 of the same issue of *SCIENCE*.)

Of course if the meridians were shown on such maps their curvature (in some of the projections commonly employed) would still reveal the fact that part of the original had

been cut away, even if the central meridian of the part used were placed as nearly upright as possible; but on the maps in question the meridians are not shown, and there are no north-and-south lines long enough to have any perceptible curvature. Neither is there any horizontal lettering that had to be kept in the same position when the map was trimmed; and even if there was a legend in one corner it would be a simple matter to cut it out and place it in a new position.

A somewhat similar disregard for appearances is often exhibited by persons who use half-tone illustrations. It goes without saying that a rectangular photograph should have its horizon (if any) and all its vertical lines parallel to its edges, unless there is some special reason for treating it otherwise; but photographs several degrees out of plumb are very often published in text-books, scientific reports and magazines, even in some magazines which seem to take pride in the quality of their illustrations.

The principal cause of this rather annoying condition is probably in many cases too much division of responsibility. A traveler who makes photographs, especially if he is working for some institution which pays his expenses and furnishes the photographic material, often has them developed and printed without his personal supervision, by some human "machine" who treats all the views alike, no matter if some of them are a little out of plumb, as is almost certain to be the case, especially with snap-shots. When the time comes to supply illustrations for a manuscript the average author perhaps looks over his negatives, or a list of them, and gives orders for prints of certain ones, without noticing that some might be improved by judicious trimming, either to make the horizon level or to cut out superfluous portions. Then the editor, even if he notices that some of the prints need trimming, may be too busy to attend to it, or more likely not equipped with suitable apparatus, so he passes them on to the engraver, who naturally reproduces each picture just as it is, in the absence of instructions to the contrary.

The publication of such "eye-sores" can be so easily prevented by either author, editor or engraver that it should not be allowed to continue any longer. Of course in some cases, as in views of lakes and rivers, there may not be any distinct vertical or horizontal lines to guide the trimmer; but in such cases one may sometimes get his bearings by remembering that any point and its reflection in a body of still water are always in the same vertical line, except in the case of objects (such as birds) moving rapidly from the observer's right to left, or *vice versa*, and photographed with a focal-plane shutter traveling vertically.

ROLAND M. HARPER

UNIVERSITY, ALA.

ANOTHER SEX-LIMITED CHARACTER

TO THE EDITOR OF SCIENCE: From work done this spring on the inheritance of mamma in swine, the writer has apparently discovered a new sex-limited character in the behavior of rudimentaries. These rudimentaries are the ones located low on the scrotum of the male, and well to the rear on the inside of the thigh of the female. The method of inheritance corresponds to the appearance of horns in Wood's crosses in sheep.

The males used by the writer both possessed rudimentaries on the scrotum and were heterozygous in nature if the interpretation is correct. Two ages of sows were used, gilts or sows just turned a year old, and sows that had just become two years of age. The results are depicted in the following table, the symbols being as follows: *R* equals factor for presence of rudimentary, *r* equals absence of same. *RR* equals rudimentaries in both sexes, *Rr* equals presence in male and absence in female, and *rr* equals absence in both sexes.

In the second table the deviation of the actual from the theoretical is wider than the writer would like, but is scarcely significant. The number of gilts are only seventeen and the average of pigs per gilt is less than with the sows. Both of these factors should complicate the results as to chance. Since there

is no appearance of rudimentaries where they are not expected the writer feels that the theory is justified in spite of the deviations.

SOWS MATED TO OLD BOAR (*Er*)

Gametic Composition Sows	No. Sows		Boars		Sows	
			Ab-sent	Pres-ent	Ab-sent	Pres-ent
<i>RR</i>	5	Expectation	0	26	11	11
		Actual	0	26	14	9
<i>Rr</i>	9	Expectation	9	27	36	12
		Actual	11	25	34	14
<i>rr</i>	18	Expectation	46	46	84	0
		Actual	48	45	84	0

GILTS MATED TO YOUNG BOAR (*Er*)

<i>RR</i>	4	Expectation	0	13	8	8
		Actual	0	13	13	4
<i>Rr</i>	5	Expectation	5	15	21	7
		Actual	7	13	18	10
<i>rr</i>	8	Expectation	19	19	23	0
		Actual	23	15	23	0

The gilts are from the sows listed in the first table and thus there are available three generations for study. The gametic composition assigned the gilts as a result of their behavior in breeding is confirmatory in every case of the composition assigned the sows.

The writer is not dogmatic in his interpretation and welcomes suggestions that may help reconcile the slight differences present.

EDWARD N. WENTWORTH

AMES, IOWA

SCIENTIFIC BOOKS

Phylogeny of the Echini with a Revision of Palaeozoic Species. By ROBERT TRACY JACKSON. Memoirs of the Boston Society of Natural History, Vol. 7. Boston: Printed for the Society with aid from the Gurdon Saltonstall Fund, January, 1912. Quarto, 491 pages with 256 text-figures and 76 plates.

The discovery of the actual phylogeny of any group of animals involves not only the combined study of the morphology and development of those animals as they exist to-day, but also the more difficult and laborious study of their fossil remains. The true phylogenist

is seriously handicapped when he deals with a group, which is poorly represented in nature's great museum, the earth's crust, and happy is he if he can find abundant material in that wonderful storehouse. Doubly fortunate is he if his training enables him to get the most from such material. One of the greatest absurdities of our persistent and no doubt necessary tendency to classify men as well as objects is the grouping by themselves as "paleontologists" those who have had this training and who specialize in the study of fossil organisms. For if a man who uses as his material the long-dead and oftentimes badly preserved animals of our museums is a zoologist, is not the man who studies in the same way similar remains preserved in the strata of the earth, just as truly one? Do either the length of time since the death of the animal or the method by which its remains have been preserved matter? Perhaps a line might be drawn between those who study fossils simply as indicators of geological horizons having in view the history of the earth as an object by itself, and those who study them as the remains of living beings whose structure throws light on the problems of phylogeny, but the latter at least are zoologists (or botanists, as the case may be) and when they combine with their paleozoology thorough knowledge of the structure and development of Recent animals, they make the best possible phylogenists. When such a worker selects for study a small sharply-defined group with a rich geological history and abundant Recent material available, and devotes years of time and the most unflinching industry to his task, the results can not fail to be of prime importance to zoologists of all sorts, everywhere.

Few groups of animals are better adapted for such study than the echini. So sharply defined is the class that its ancestry is hidden in oblivion and not a single connecting link with any other class is known. There is no animal either Recent or fossil of which it can not be affirmed either "this is" or "this is not an echinoid." Moreover, the class is relatively small, only about five hundred living species being known with perhaps three times

as many fossil. The latter occur in all geological periods from the Ordovician to the Recent. Much of this material is beautifully preserved too, at least so far as essential structures go, for the hard test and lantern of a sea-urchin are exceptionally satisfactory objects for geological preservation. Finally sea-urchins have long been favorite objects of study, and their anatomy, development and life history are as well known as those of any marine invertebrates. If, therefore, the investigation be undertaken by the right man, the possibility of really working out the history of the group, were unusually favorable, and it is but the simple truth to say that in his "Phylogeny of the Echini" Dr. R. T. Jackson has shown himself to be that man. This monumental work sets forth the actual developmental and evolutionary history of the echini so fully, so fairly and so convincingly that it may be said with little fear of contradiction, there is no other group of animals of equal importance the main lines of whose phylogeny are more definitely and certainly known. Moreover so extraordinary is the amount of accumulated fact and so suggestive are the interpretations offered that there is something of interest in the volume for every one attracted by the problems of evolution, be he zoologist or botanist.

The book is dedicated most appropriately to Alexander Agassiz and Alpheus Hyatt, the former the Nestor of students of echini, the latter the originator or promoter of the principles and methods to which Jackson is himself so ardently loyal. Indeed the most striking characteristics of the volume are the emphasis placed on "stages in development" and the persistence with which the facts are marshalled in support of the "recapitulation theory." Those who deny the existence of stages and the validity of the recapitulation theory will find it exceedingly difficult, if not impossible, to meet the arguments and interpretations with which the writer defends his position. Second only to the emphasis on stages is the stress laid on variation and its significance. In the introductory pages, variations are grouped under five heads (*arrested*,

regressive, progressive, parallel, aberrant) and the meaning of each term is clearly explained. That variation is nearly always significant and that its significance may be determined are two cardinal principles which the reader of this book can scarcely doubt.

The terminology adopted by Jackson is as free from technicalities as possible and there are scarcely any new terms introduced. Those which are proposed, as for example "mid-zone," are simple, readily understood and meet a real need. In the case of such terms as have been used in different senses by previous authors, as "peristome," Jackson has adopted that usage which has appealed to him as simplest and least open to misunderstanding, and consequently even those who prefer a different sense can not mistake his meaning.

The extensive investigations which Jackson has made into the morphology of Recent echini have led him to some interesting discoveries of structures hitherto overlooked. A notable illustration of this is the presence or absence of pits in the upper end of the half-pyramids which compose the lantern. These pits have apparently been overlooked hitherto, though they seem to be of real systematic importance and even of ordinal value.

In his choice of generic and specific names Jackson has followed the International Code, but not at the expense of his judgment or common sense. As an illustration of his mental attitude, his sensible treatment of *Archæocidaris* vs. *Echinocrinus* is illuminative. Nobody questions that *Echinocrinus* has priority, but Jackson well says: "This name, however, is misleading, was based by Professor Agassiz on a misconception of affinities and has been abandoned for some sixty years in favor of the entirely appropriate *Archæocidaris* of McCoy. . . . To revive the old name *Echinocrinus* . . . will make confusion at present and in future, and no gain to any one." Another taxonomic snarl which Jackson has courageously untangled is that involving the name *Diadema*. For years it has been known that this name belongs to a cirriped, although it has also been in use for a genus of butterflies and for one of the best-known genera of tropical sea-

urchins. Students of the echini have persisted in its use and a family and an ordinal name based upon it are both universally adopted. Jackson's statement of the case (p. 27) is clear and convincing and his proposed substitutes *Centrechinus*, *Centrechinidæ* and *Centrechinoidea* are appropriate and euphonious. Now that the Gordian knot is cut, it is to be hoped that zoologists will no longer use *Diadema* for either sea-urchin or butterfly.

Following his introductory pages, Jackson divides his book into three parts. The first of these is entitled "Comparative Morphology of Echini." It includes 168 pages, crowded with observations and interpretations of the typical structure of the test and lantern, and variations therefrom. One notes the absence of any discussion of the pedicellariæ and of the non-calcareous organs, but as these parts seem to have little phylogenetic significance the omission is perhaps not important. We may, however, hope that some zoologist will be moved to institute ere long a similar thorough comparative study of these less significant systems. So far as the pedicellariæ are concerned, Mortensen already has accumulated a mass of important material. Jackson's opening paragraph is a fine defense of the claim that paleozoology is only one aspect of zoology. Then follow sections on the form of the test, orientation, the pentamerous system and variation therefrom, the structure of the skeleton, growth, ambulacrum of the corona, interambulacrum, basicoronal plates, imbrication, spines, peristome, ocular and genital plates, periproct, Aristotle's lantern and perignathic girdle. It is impossible in a review like this to give any adequate conception of the wealth of these sections; only the most striking features may be noted. The repeated references to Lovén and his work show in what high esteem he is held, while the constant emphasis on the significance of both normal structures and variations is very noticeable. Variants from pentamerous symmetry are shown to be exceedingly rare; only 25 were recorded prior to Jackson's work, but he has studied 71, of which 60 were found in the fifty thousand Recent echini personally examined by him.

He arranges these variants in twenty groups, showing that tetramerous specimens, though rarely completely symmetrical, are the most common. The study of both normal and variant tests led Jackson to the conclusion that the interambulacral plates are merely space fillers and always originate against the oculars. He therefore holds that the test of a sea-urchin consists, not of ten equally important areas, but of *five* only. Each of these is capped by an ocular plate, beneath which arise the two columns of ambulacral plates with one or more columns of space-filling interambulacral on either side. The growth of the test seems to take place chiefly on its outer surface. That the inner is more primitive is pointed out and demonstrated by interesting evidence. Much stress is laid on resorption of the calcareous matter during growth as a developmental factor, particularly in relation to the peristome. The matter of imbrication or non-imbrication of coronal plates is not considered to be of special phylogenetic importance. The covering of the peristome is carefully considered and six different types are pointed out. A new term, "non-ambulacral," is introduced in this connection, which is to be welcomed as accurate and useful; it is applied to those plates of the peristome which are not homologous with any of the coronal plates.

The section discussing the mutual relationships of ocular and genital plates occupies 79 pages and is one of the most remarkable contributions to echinoid morphology which has yet been made. With a patience and zeal most extraordinary, Jackson has personally studied fifty thousand specimens of 137 species of Mesozoic and Recent regular echini and has thus inspected, not hastily and casually, but with real care, a half million genital and ocular plates! Certainly results and opinions reached after such a study are worthy of more than ordinary consideration. The chief conclusions to which the author comes are as follows:

1. The position of oculars and genitals with reference to each other and to the periproct is not dependent on size or age in adults, but is a species character. Of course, like all

specific characters it is more firmly fixed in some cases than in others, but in only a very few cases is there any room for question as to what the species character in this particular is. From a purely taxonomic standpoint this discovery is of very great importance, but its chief interest lies in its phylogenetic bearings, upon which Jackson very properly lays particular emphasis.

2. In Recent regular Echini (except perhaps the Aspidodiadematidæ) the oculars in very young individuals are all exsert (*i. e.*, not in contact with the periproct); they are shut out by the five genitals forming a closed ring. As the individual grows, however, one or more, even all, may become insert (*i. e.*, reach and touch the periproct) thus separating the adjoining genitals. The species character is, however, reached very early in life in most echini, when the individual is less than half grown, often when it is still but a few millimeters across. Even the variants which progress beyond the species character are found almost wholly among the small specimens. Exceptionally large and fine specimens generally show the species character.

3. Of the 32 possible arrangements of ocular plates with reference to the genitals, ranging from all exsert to all insert, only 22 were found and of these 14 were so rare that they all together characterized only about 1.5 per cent. of the specimens. The other eight have a very fixed and characteristic order of appearance. For example if two oculars only are insert in the adult, they are the two of the bivium (*i. e.*, oculars I., V.); if three, they are these two plus ocular IV., and if four, they are these three plus ocular II. The variations from this sequence are exceedingly interesting and important and are very fully discussed.

4. The first ocular to become insert appears to indicate a family character; it is usually ocular I., but in the Cidaridæ, in the Arbacidæ and also in the Echinometridæ it is ocular V.

5. While the very small apical system of the Echinometridæ shows that a highly specialized family does not necessarily have a large apical disk, with oculars all insert, it appears to be

true that within any given family the most specialized genus, and within any genus the most specialized species, has the largest number of insert oculars.

Aside from these important general conclusions, mention should be made of the occurrence of what may be called "right-ocularized" sea-urchins in species which normally are "left-ocularized," *i. e.*, some individuals have oculars I, V., II. insert, when I, V., IV. is the species character. Also deserving of special note are the remarkable peculiarities of the echini of the west coast of South America. Particular attention should be called to the invaluable tables on pages 100, 142, 143 and 154-164 and to the diagram (Fig. 176) on page 153. The detailed studies of the development of the apical disk in *Strongylocentrotus dröbachiensis* and of geographical variation in that species and several others, notably *Tripneustes esculentus*, deserve far more than the passing commendation possible here.

A discussion of the special characters of genital plates occupies pages 165-173, among the interesting points considered being the exclusion of genitals from the periproct, the fusion and splitting of genital plates, and the number and position of the genital and madreporic pores. The characteristics of the periproct occupy four pages and the very important point is emphasized that the so-called suranal plate is not a primitive but a secondary feature. More than twenty pages are filled with a discussion of the "Aristotle's lantern," including its muscles, and the periganthic girdle which is really a part of the same organic system. The pits, already mentioned, which were discovered in the tops of the half-pyramids of the Centrechinoida, are described here. Stress is laid on the importance of the structure of the lantern and teeth for purposes of classification and the Centrechinoida is divided into three very satisfactory suborders (*Aulodonta*, *Stirodonta*, *Camærodonta*) based primarily on these characters. The fundamental differences between auricles and apophyses are clearly pointed out and all the known varieties of each are discussed.

One finishes the reading of this first part of the volume with amazement at the array of facts it contains and with admiration at the way in which they are marshalled and the common sense with which the conclusions are drawn. There is no attempt to be startling and the newly discovered facts are not made the bases of wild hypotheses, but each theoretical conclusion is presented with the facts in support of it so fairly, so open-mindedly, as to carry great conviction.

To the taxonomist Part II, "Systematic Classification of Echini," which fills pages 199-234, will prove of particular interest. The author begins with a brief statement regarding his inability to accept Dr. Mortensen's divisions based on differences in the pedicellariæ and states the principles which have guided him. The recently suggested close relationship between echini and crinoids is emphatically disapproved, nor is any direct connection between sea-urchins and starfishes deemed at all probable. The original stock from which the echini have sprung is very likely to be found among cystoids. The "Key" beginning on page 201 includes all the orders of echini accepted or proposed by the author, all the families of regular Recent echini and all the families and genera of the Paleozoic era. This key is very fully elaborated, so that it is far more than the ordinary key. It might perhaps be called a synopsis, but as it is arranged in the customary dichotomous form it is very usable and will prove most helpful to all workers on either Recent or fossil echini. Nothing of the kind has hitherto been available and the need has often been sorely felt. On page 209 is given a remarkable "bird's-eye view" of the phylogeny of the echini as worked out by Jackson. This family tree well deserves most careful study and brings home to the reader certain fundamental conclusions of the author which may be briefly stated here. (1) *Bothriocidaris* is the nearest known approach to the primitive echinoid stock and serves as the root, or, perhaps better, the trunk of the tree. (2) The remaining characteristic Paleozoic forms are not in any sense ancestral to our modern

echini, but represent totally different branches which reach their culmination in the Permian.

(3) The *Bothriocidaroid* stock was the origin of a *Cidaroid* branch, which in turn gave rise to the *Centrechinoidea*, and from this order all the other Recent echini have sprung. So firmly has Jackson grounded these conclusions on the facts of morphology, embryology and paleontology that it is difficult indeed to doubt their essential truth. Of course the time-honored divisions *Palæchinoidea* and *Euechinoidea* no longer have any use since they are artificial and unnatural.

Following the key are detailed accounts of each of the groups given therein. Part of this can not avoid being elaborated repetition, but there is added much that is important or suggestive, particularly concerning the interrelationships of the different groups. Great importance is very naturally given to the structure of *Bothriocidaris*, which is emphatically stated to be "the most primitive type of echini." Four new genera from the Paleozoic are described and their relationship to previously known forms is clearly brought out. The progressiveness of structure in the *Palæechinidae* is emphasized and the ascending series is beautifully worked out, forming one of the most convincing demonstrations of "stages" imaginable. In this connection figure 237 on page 231 deserves special mention.

In Part III, "Paleozoic Echini," is to be found the more distinctively systematic and paleontological portion of Jackson's work, but it would be a great mistake for the phylogenist or student of variation to feel he could pass over this part superficially. It is crowded with details of morphology and of variation that are of very real importance. Besides forty species of *Archæocidaris*, most of which are based on fragments of spines or scattered plates, Jackson accepts eighty species of Paleozoic echini, grouped in 23 genera. Of these species, 22 are here described for the first time. The genera are grouped in eight families under four orders, but the *Perischoechinoidea* with four families includes all the characteristic Paleozoic forms, of which satisfactory

material is known, except *Bothriocidaris*. (The *Cidaroida* of course are not characteristic of the Paleozoic and the structure of the *Echinocystoida* can not be considered satisfactorily known.) After a brief introductory note there is an interesting chapter on "Geological Distribution" which will prove of particular interest to all who have little knowledge of paleozoology. Then follow the orders, families, genera and species in regular sequence for 208 pages. In view of its importance in Jackson's scheme, *Bothriocidaris* is again given particular attention. The very interesting fact is noted that this rare and extraordinary fossil was figured by Aldrovandus in 1618. Under the *Cidaroida* is given the description of a new species of *Miocidaris* from the Lower Carboniferous of Colorado. The discovery of this species is of the greatest interest and from Jackson's point of view of special importance. For the only argument against his phylogeny of the echini which presented serious difficulty was the apparent non-existence before the Permian of echini with only two columns of interambulacral plates. While appeal might have been made with perfect propriety to the "imperfection of the geological record," that last resort of all hard-pressed phylogenists, it is far more satisfactory to have this beautifully preserved cidarid as tangible evidence of the existence of the order so far back in the Paleozoic.

In the consideration of *Palæodiscus*, the extraordinary interpretation placed on its structure by Sollas and Spencer is rejected and a perfectly natural explanation is offered of the appearance which has led to the unfortunate belief that the fossil represents a sort of connecting link between sea-urchins and starfishes. To make his record of Paleozoic forms complete, Jackson has included some forty species of *Archæocidaris* largely based on fragments but he is the first to admit (pp. 256, 257) that most of these have little paleontological, less systematic and no morphological interest. Of the new genera *Hyattechinus*, with three remarkable species, two of them new, is the most noteworthy as it has the largest number of columns of interambulacral plates known

among echini and the form of the test is, in each species, unusual. The genus similarly named in honor of Lovén is less remarkable, but is of interest because it forms one of the steps in the progressive differentiation of the Palæechinidæ. In this series, *Lovénechinus* is intermediate between *Maccoya* and *Oligoporus*. Under *Melonechinus* (this name having to replace the more familiar *Melonites*, which is preoccupied) particular stress is laid on the support which the study of that genus with its fourteen species gives to the recapitulation theory. The last genus discussed, *Meekechinus*, is a new one and like *Hyattechinus* of special interest, but in this case it is the ambulacra which are highly specialized, having in each area twenty columns of plates. The teeth also are remarkable in being serrate. Altogether this striking Permian genus is a fitting climax to the remarkable series of forms beginning in the Ordovician with *Bothriocidaris*. While no one will question the right of Hyatt, Lovén and Meek to the honor Dr. Jackson has done them in connecting their names with these interesting echini, those of us who are utterly opposed to the mixing of honor and sentiment with taxonomy must regret that impersonal generic names were not preferred.

In compiling such a systematic monograph as is presented in Part III., one invariably finds forms so imperfectly described or so incompletely known that it is virtually impossible to determine their relationship to those better known. Jackson has very wisely gathered these unsatisfactorily known forms among Paleozoic echini under two heads, "Incertæ Sedis" and "Nomina Nuda." Under the former are listed 35 species based on single plates, fragments of spines or incomplete and badly preserved tests. Many of these can be referred correctly to the family and some even to the genus, but, as their real relationship to the known forms can not be determined, it is a great advantage to have them listed in this way and not intercalated among the valid species where their dubious nature might easily be overlooked. There are eleven *Nomina Nuda* listed, of which *Hetero-*

cidaris keokuk and *lævispina* Hall have a curious history, here given by Jackson in full. A half a dozen unrecognizable fossils, three of which may be Cystoids, are listed under the heading "Paleozoic Forms incorrectly referred to Echini." A very full bibliography of 248 titles and an equally satisfactory index covering 17 pages complete the book.

A special word is demanded by the illustrations with which the memoir abounds and which are as fine as they are abundant. With four unimportant exceptions, every Paleozoic species accepted in the text is figured and of many species particularly the more important forms, both photographs and drawings are used to show the appearance and structure. Moreover a large proportion of the figures are from the type specimens. The morphology of the test and lantern of Recent species is lavishly illustrated and interesting variants are equally well shown. Particular attention should be called to the "summary figures," if such a term may be used, showing important morphological characters as they appear in different groups of echini. Of these, that on page 54 illustrating the features of the ambulacra, the one on page 80 showing the various kinds of peristome and that on page 184, which gives the different characters of lantern and teeth, are of particular importance, but the others on pages 70, 134, 148, 193 and 197 are really of no less value.

The chief fault of the book, if one must be discovered, would seem to be occasionally unnecessary reiteration. This is of course only an exaggeration of a virtue due to the author's desire to set forth his facts with perfect clearness and to marshal them in vigorous support of "stages" and the recapitulation theory. The same facts or group of facts are sometimes repeated in several different places, though usually from different points of view. This is in part due to the arrangement of the book, by which general morphology is discussed first and is followed by the application to taxonomy and the detailed study of the Paleozoic forms. Of course the latter sections necessarily contain a large amount of morphological detail involving considerable

repetition. But the fault seems to be due also to a fear that the reader will have forgotten or overlooked or misunderstood the significance of something the author considers of great importance. This desire to be perfectly understood leads to an exceptionally large number of references to plates and figures and to other passages in the text, so that the reading tends to become slow and laborious, or if the references be ignored, it tends to be superficial. In the explanation of the plates, the author's care for details is shown to a marked degree. It is safe to say one rarely sees a volume in which the explanatory text for the plates is so complete. So far as the statements or interpretations of facts are concerned, the author's freedom from obvious error and from ill-judged conclusions is really remarkable. In all his references to other workers, Jackson shows not only an open-mindedness and fairness of judgment, but a courtesy even in disagreement that is delightful. At the same time, there is no glossing over of mistakes in earlier publications, no matter whether made by himself or some other authority. The perfectly evident desire to know the facts as they really are wins the reader's confidence and the unusual freedom from ambiguity prevents any misunderstandings.

The typographical work reflects the greatest credit on the Cosmos Press, especially when one considers the numerous tables with percentages often worked out to two decimals and the abundance of scientific names and technical terms. That slips of the pen and occasional transposed letters should occur is inevitable; the extraordinary thing is how very few there are in this volume. Nearly all have been detected and gathered together on the page of "Errata and Addenda" which follows the index, but they are mostly so trivial as to be of absolutely no importance. On page 188, however, the phrase "distinct continuous base" carries no meaning and we are therefore glad to have the Errata explain that it should read "discontinuous base." On page 251, we are told by the Errata, the words "starfish" and "sea-urchin" have been trans-

posed in the author's discussion of *Paleodiscus*, an error which if uncorrected would seriously affect the argument. Two slips not noted in the "Errata," although not of great importance, may perhaps be worth pointing out. On page 121, in the footnote it is said that *Toxopneustes atlanticus* was described by Mr. Agassiz as *Leptechinus atlanticus*; the generic name should read *Lytechinus*. On page 238, the order Bothriocidaroida is inadvertently attributed to Jackson, 1896, whereas Duncan introduced the term in 1889.

When Alexander Agassiz's "Revision of the Echini" was published in 1872-74, it marked an epoch in the study of sea-urchins. It has literally been the foundation of all subsequent work throughout the world. It brought together and summarized the knowledge of echini as it stood at that time and much of the work it involved need never be done again. Jackson's "Phylogeny of the Echini" is a similar summing up of our knowledge to-day from the twentieth-century point of view and, like the "Revision," it marks an epoch. We are all to be congratulated that this fitting companion volume to the "Revision" is the work of an American zoologist; the Boston Society of Natural History is to be congratulated on the publication of a memoir of such unusual merit; and Dr. Jackson himself is most of all to be felicitated on the production of such a profound and masterly piece of research.

HUBERT LYMAN CLARK

The Parasitic Amæbæ of Man. By CHARLES F. CRAIG, M.D., Captain, Medical Corps, U. S. Army. 1911. J. B. Lippincott Company. Pp. 253. \$2.50.

This book has no doubt been welcomed by many medical men, for it brings together the scattered literature in a complex field. In making such a compilation it is natural, perhaps, that the author should be biased by his own investigations. However, it is unfortunate that this fixed attitude should be so much in evidence throughout a work the purpose of which is to aid medical men in their studies of amebic infections. A more critical

and less positive method of presentation would have increased the value of the work.

On the whole, the descriptive portions of the work, covering the morphology, biology, classification, nomenclature and species of parasitic amœbæ, are excellently executed and well illustrated.

A firm belief in the stability of the parasitic species *Entamoeba histolytica*, *E. coli* and *E. tetragena* and the ease with which they may be differentiated on morphological grounds, provided one has studied them long enough, is made evident by the author. In the historical review it is said that Councilman and Laffeur gave "a most excellent description of the parasite now known as *Entamoeba histolytica*." This is done in spite of the admission that comparatively recent researches have shown that species determination must rest mainly upon a knowledge of the reproductive cycle. Again, the author is not very consistent in including in his list of unquestionable species half a dozen organisms the life cycles of which have been only incompletely studied.

No adequate discussion is made of the possible adaptability of amœbæ to a parasitic existence, although on *a priori* grounds one would suspect that some such process might still be taking place in nature. The answer to this question is evidently of the greatest importance from the standpoint of the prophylaxis of amœbiasis. The only extensive experiments made to adapt amœbæ to a parasitic existence have been performed by Musgrave and Clegg in Manila. In criticizing the experiments performed by these investigators the author is rather indefinite and dismisses the importance of their work from the reader's mind by stating that "while lesions were undoubtedly produced by the mixed cultures of amœbæ and bacteria, the authors could not, with their methods, be sure of excluding the spores of *E. histolytica* or the encysted forms of other amœbæ pathogenic to the animals used in their experiments" (p. 63). Later (p. 66) he lays stress upon the feeding of "pathogenic bacteria" along with the cultivated amœbæ—in spite of the fact that it is well known that the typhoid bacillus and

cholera spirillum are not pathogenic when fed to the species of monkey used (*Macacus cynomolgus*). Certainly one can not criticize the cultures of amœbæ used by Musgrave and Clegg, for these were the descendants of a single amœba growing in "pure mixed culture" with a single species of bacterium. If it is argued that their animals were infected naturally either before or after the experimental feedings, then it must be shown that spontaneous amœbiasis is of such frequent occurrence in monkeys in Manila as to render these animals worthless for experimental purposes.

Again this state of mind is exhibited in discussing the cultivability of the parasitic amœbæ: "What I have always believed and stated, *i. e.*, that the parasitic amœbæ of man have not been cultivated" as Craig says, he believes to be supported by the recent work of Whitmore, who took cultures he obtained in Manila to Hartmann's laboratory and found them all to be free living species. Yet he makes no mention of the work of Fantham, whose article is quoted in his bibliography, to the effect that, by special cultural methods, he was able to identify two cultures obtained from Manila and kept on Musgrave and Clegg's medium, as *Entamoeba coli*.

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BOTANICAL NOTES

BOTANY BY THE EXPERIMENTAL METHOD

A GOOD many years ago some of us introduced to American colleges the laboratory method of learning about plants and this brought about a revolution in botanical teaching mostly for the better, but not wholly without some distinct losses. It is doubtful, for example, whether the pioneers in the laboratory method in this country ever contemplated the total abandonment of field work which followed in some places. It is pretty certain that they intended to *add* the laboratory method to the existing methods of study, which included the textbook, the field and the herbarium. Certain it is, however, that many teachers supposed that the adoption of the laboratory

method was to be followed by an abandonment of everything that had been done in the past. This was a serious error of judgment, and has led to no end of wasteful educational experiments. Because the laboratory method is good in one place is no proof that it is good in all. When I want to learn all that I possibly can of a new country I visit it if I can do so, and see all that I can of it, but I do not hesitate to use maps and read books pertaining to the country. I may even ask the people who have lived there longer than I to tell me all that they know. In this way I build up my knowledge of the country, and it is good and reliable, far more so, perhaps, than if I had relied wholly upon what I could have seen personally.

And so it is in botany. I must surely see as much for myself as possible, but life is quite too short for me to hope to see all that is known with my own eyes. Here and there, at critical and strategic points, I must see for myself and then I can go a long ways, when I must again get my reckoning by an observation. The mariner does not sail the seas by doing nothing but make mathematical observations. It would be slow sailing indeed were he to do so.

And yet this is just what some of the book-makers are planning to have the children do. They are to learn everything about plants by the experimental method. They lose sight of the fact that there is no special saving grace in the labor of making experiments. We make experiments on plants in order that we may learn botany; we do not learn botany in order to make experiments on plants. Let every teacher remember that useless experiments involve as real a waste of time as dawdling or idling. I can walk from Lincoln to Denver, but it takes so much time that it will pay me far better to be carried there on a railway train.

All this is suggested by Mr. Payne's "Manual of Experimental Botany" (American Book Company), whose purpose, the author tells us, is "to teach botany by experiment." In two hundred and twenty-eight "experiments" and "exercises" the pupil is led over

and into and among a great many facts pertaining to plants. Some of these exercises will prove to be interesting and helpful to pupils, but there are so many of them that it is quite impossible for the pupil to perform them with any care. It would have been far better to have selected a much smaller number, and to have placed them properly in a scheme outlining the subject. *That* would have introduced the pupil to the science of botany, *i. e.*, to an organized system of knowledge of plants. As it is, the child will have spent a great deal of time and energy in the making of experiments not definitely correlated, nor organized into a science. The pupil will have the results (more or less accurate) of a considerable number of experiments, but they will not constitute botany, that is, the science of botany, and it may be doubted whether in this unorganized form they will have any educative value. It would not be a bad thing to use this book as a store from which to draw such experiments as the teacher and pupil might wish to use in going systematically over the field of botany, although in some cases we must warn the teacher that the experiments will not "prove" all that they are supposed to demonstrate (*e. g.*, 130, 131, 132, 139, 145, 148, etc.). On the other hand, many of the experiments are well planned, and will prove interesting and instructive.

A HANDFUL OF LITTLE MANUALS

It would seem that the solution of the problem of a handy manual for field work in systematic botany is to be reached by the compilation of little books covering restricted areas, or even confined to limited portions of the year.

Several years ago Professors Clements, Rosendahl and Butters brought out a little pamphlet of 40 pages entitled "Guide to the Spring Flowers of Minnesota," which has been well received by the schools of the state, and to this they have added a "Guide to the Trees and Shrubs of Minnesota," "Guide to the Ferns and Fern Allies of Minnesota" and "Guide to the Autumn Flowers." In the

same series we have also "Minnesota Mushrooms," by Professor Clements.

A year ago A. O. Garrett, of the Salt Lake City High School, published a little book of 106 pages, entitled "Spring Flora of the Wasatch Region," and including "the eastern edge of the Great Basin as far south as Manti" (central Utah). This is now followed with a second, considerably enlarged edition of 139 pages. It must be very useful to pupils in the schools of the region covered. It would be still more helpful if not confined to "spring plants" alone ("before June 15").

Much like the last is the "Spring Flora of the Intermountain States," by Professor Dr. Aven Nelson, of the University of Wyoming (Ginn), which in 202 pages covers Colorado, Wyoming, Montana, Idaho (excepting the northern part), a portion of eastern Oregon and the northern half of Utah. The treatment is much like that in the Wasatch Flora, and must be equally useful in the much larger region included. Here again one wishes that the "spring" limit could be removed.

Hall's "Yosemite Flora" (Elder, San Francisco) is a book designed to appeal in paper, pictures and binding more to the tourist than to the pupils in schools, and yet it must prove a most inspiring field manual for pupils fortunate enough to have access to its keys and descriptions. While called a Yosemite Flora, we are told that it is also "designed to be useful throughout the Sierra Nevada Mountains." Eleven most artistic plates and 170 text figures add much to the usefulness of the book for the beginner.

The "Flora of Nebraska," published by N. F. Petersen, instructor in botany in the Louisiana State University, is an attempt to name every plant (conifers and flowering plants) growing without cultivation in the state. It is modeled after Rydberg's well-known "Flora of Colorado," and like it the treatment is by the copious use of keys, by means of which the phyla, classes, orders, families, genera and finally the species are successively found. And after the species is determined by this method one finds a little paragraph assigned to it containing habitat,

distribution and locality data. It will be useful to high-school pupils, in spite of the rather numerous typographical errors, due to the employment of a printer unaccustomed to scientific printing.

Here may be mentioned Professor Schaffner's "Key to the Families of Seed Plants" designed to aid his students (Ohio State University) to distinguish the natural plant families by carefully devised keys.

BOTANY IN THE MOUNTAINS

The University of Colorado Mountain Laboratory at Tolland, Colo., will hold its session this year, beginning June 24 and ending August 2, 1912. There will be a general course in field biology, in which both animals and plants are considered in relation to their environment, and also courses in systematic botany, ecology and biology of ponds and streams. Special attention will be given to research work.

The laboratory is situated in an interesting region at an altitude of nearly 9,000 feet. Tolland is the station for Boulder Park, a mountain valley surrounded by timber-clad hills. Within easy reach of the laboratory are typical pine and spruce forests, mountain meadows, narrow canyons, glacial lakes and alpine tundra. In addition to regular daily field trips which take the student to these various habitats of animals and plants there will be all day excursions by rail to the foothills and even to the plains for the purpose of making comparative studies of the flora and fauna of these localities. Professor Francis Ramaley, of the University of Colorado (Boulder), is the director of the laboratory.

CHARLES E. BESSEY

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SPECIAL ARTICLES

NITRATES IN SOILS¹

THE fertilizing value of materials that we now know to contain nitrogen was of course

¹ Paper read by invitation before the Society of American Bacteriologists at Washington, December, 1911.

recognized very early, though nitrogen was first recognized as a distinct element in 1772 by Rutherford.

Later it was demonstrated that nitrogen is an element indispensable to life, present in all organisms and the mass of literature, scientific, popular and commercial, concerning nitrogen in its various forms and their relation to plant growth is overwhelming to the student.

Yet, notwithstanding the long period of time during which we have recognized the importance of nitrogen, the aggregate of many life times that have been devoted to its study or the thousands of pages that have been published concerning its relation to plants, there still remain some of the most fundamental questions for solution.

The universality of nitrogen in plants is well authenticated. The amounts removed from the soil by a few leading crops are as follows:

Corn (45 bushels per acre) . . .	63 lbs.
Cabbage (15 tons per acre) . . .	100 lbs.
Clover hay (2 tons per acre) . .	82 lbs.
Wheat (15 bushels per acre) . .	31 lbs., etc.

Not only is it present, but it is indispensable, as has been repeatedly shown by careful water- or sand-culture experiments. Just how and why nitrogen is essential is a much more difficult question. It is a necessary element in the composition of protoplasm, and many other organic substances. It aids in the assimilation of other needed elements, and in photosynthesis. These functions of nitrogen would account for the need of a certain amount of available nitrogen in soils used for crop production. But it is found that soils with apparently an abundance of available nitrogen for the supply of many crops are benefited by the addition of still more nitrogen. Various theories which we will not enter upon here further than to point out that nitrogen or its compounds may serve other uses than by being merely absorbed or absorbed and assimilated have been proposed to explain this peculiar fact. What these other uses are is one of the large questions, as yet barely disclosed.

Whatever other uses nitrogen may serve, that of a food element is unquestionably a preeminent one, and it is with this phase of the nitrogen subject alone that I shall deal.

Admitting the importance of nitrogen in assimilation the next question is: "In what forms is nitrogen available to the plant?" This, as has been the fate of many questions in biology, received its emphatic answer years ago, an answer that asserts itself convincingly through thousands of popular and scientific articles and text-books, but one which seems to be founded on very insecure evidence and one which is likely to be largely modified as research progresses.

The popular, almost the universal conception of available nitrogen is expressed in some such words as these, which are taken from prominent texts by famous authors and mostly from recent works.

The majority of farm crops can use only that part of the nitrogen in the soil that is present as nitrate¹ and on a later page:

The plant can make use of the nitrogen only in the form of nitrates.

The nitrates are the chief source of the nitrogen supply of green plants.²

Sulphate of ammonia . . . must be nitrified before the nitrogen is available to plants.³

The conversion of the ammonia formed during the process of putrefaction into the nitrates is a matter of greatest importance in soil fertility. . . . A soil to encourage nitrification must, then, have suitable basis. The question of soil fertility is, then, in its last analysis a bacteriological problem.⁴

This conception of nitrates has inevitably focused attention on nitrates as a soil factor of preeminent, of indispensable importance. It makes them appear so valuable that their coming and going are of superlative import and their failure to attend to spell disaster.

The subject assigned to me is "Nitrates in

¹ Vivian, 1909.

² Bergen and Davis, "Principles of Botany," pp. 233.

³ Percival's "Agricultural Bacteriology," p. 142.

⁴ Frost and MacCampbell, "General Bacteriology," 1910, p. 288.

Soils." I shall consider this subject under several heads as follows, setting aside purely physical and chemical phenomena and limiting myself to the biologic aspects of the question.

The origin of nitrates in soil nitrification and nitratation.

The destruction of nitrates in soil denitrification.

Methods.

The actual importance of nitrates.

Nitrification consists in the conversion of ammoniacal nitrogen into nitrites then nitrates, processes shown by the classic work of Winogradsky to be dependent on two separate groups of bacteria, the nitrite and the nitrate bacteria. Winogradsky's work has been abundantly confirmed and is not to be questioned. And so far as we know yet all nitrification results from this dual activity, the several reports that have been made of direct nitratation of organic nitrogen or of ammonia by bacteria lacking proper confirmation.

Ammonia is thus essential to nitrate formation and ammonification of organic nitrogenous substances is an essential preliminary step. Ammonifying bacteria are of numerous species, indeed some years ago in my laboratory a long search for soil bacteria that could not ammonify ended in failure. Ammonification in the light of present knowledge appears to be an absolutely essential process in the circulation of nitrogen, but the need is amply met and in no soil that I know of, and we have ourselves examined many hundreds, is there any actual deficiency in ammonifying power.

Recently the Rothamsted Station has attributed low yields to low ammonifying power due to consumption of ammonifying bacteria by predatory protozoa. This condition may exist in exceptional cases, but that it is in any wise general is not probable.

Nitrifying organisms have generally also been assumed to be present practically everywhere and in ample numbers. The results of a Bacterial Soil Survey conducted in my own laboratories and about to be published show that this assumption is not warranted. In a large per cent. of the soils tested the N.E.

was very low. It appears, therefore, that while a deficiency in ammonification is not to be feared there may be instances, perhaps many of them, where the amount of nitrification falls below that of the nitrogen equivalent of a good crop. Why nitrification is vigorous in some soils and very poor in others is not known. In some instances it may be referred to unfavorable acidity, moisture, etc. Many cases are due to causes as yet unknown. That abundance of organic matter does not inhibit nitrification was clearly demonstrated in our own experiments, in which vigorous nitrification occurred in pure cow manure.

On the other hand, an exceptional case of injury from too great nitrification has recently been reported by Sackett.

Denitrification is the destruction of nitrates. It is brought about by many species of bacteria and may result in reduction of nitrates, to ammonia, various oxides or even to free nitrogen. This is unquestionably a detrimental process if it proceeds below the ammonia stage. The conditions necessary to denitrification are usually stated to be the proper organisms, moisture and organic matter. The organism is conceded to be commonly, almost universally present. Yet the fertilizer formulæ of the chemist and agricultural teacher usually call for an admixture of nitrates with dried blood, cottonseed meal, etc., thus surely furnishing ideal conditions for denitrification. Theory here opposes practise and as yet no decisive experiments have shown which is correct.

Methods.—I can not refrain in passing from referring to the absolute necessity in soil bacteriological work of making the tests in soils and not in solutions. Winogradsky found that in solutions organic matter inhibited nitrification. From this he and others have generalized that it does so in soil, a conclusion that is far from the truth, as our experiments have conclusively shown.

THE ACTUAL IMPORTANCE OF NITRATES

In all of the foregoing discussion we have assumed that nitrates are the necessary or at

least by far the most readily utilized form of nitrogen. The vast amount of research carried on in many laboratories regarding the processes of nitrification and denitrification indicate that these phenomena are regarded as of high significance and nitrogen of superlative value. Is this so?

Nitrogenous organic matter may be classified as proteids, albuminoids, amides and alkaloïds. The larger part of the organic nitrogen in soils probably consists of acid-amines and amino and amino-acids.

To what extent may these or their degeneration products, particularly ammonia, serve as plant food?

A few years ago most special students and perhaps all general writers would have said that these substances must undergo nitrification before they are available to plants. To-day, without much evidence, perhaps without any evidence that will stand searching criticism, there is a tendency among some writers to hedge on this point and to speak of ammonia as well as nitrates as possessing available nitrogen. We even hear the term "active nitrogen" embracing ammonia and nitrate nitrogen.

The evidence on this question is too voluminous to bring before you, but we may summarize it something as follows:

Innumerable experiments have been made bearing upon the relative availability of nitrate and ammonia nitrogen to plants. Most numerous of such have, of course, been field tests of ammoniacal compounds and of nitrates drawing conclusions from the yield or the crop analyzed. Such tests are manifestly inconclusive, since in all cases the question of nitrification in the soil is an ignored factor and it is not in reality known whether the ammonia that is applied to the soils is used as such or is first nitrified or indeed whether the reverse may not be true, viz., that the nitrates have been reduced to ammonia and utilized in that form. The general conclusion that can be drawn from such experiments is that ammonia applied to soils does not, with most crops, on most soils, give so large crop returns as do nitrates. The common ratio of

utility is generally given as something like 60 or 70 to 100. This conclusion varies, however, for different crops, different soils, different times; and such experiments are far from giving a solution of the fundamental question.

Another line of attack is by means of water-culture experiments. Many such lack bacteriological control and the conditions regarding nitrification are not known. A few have been conducted with rigid bacteriological control and do actually prove that a plant can assimilate ammonia without its previous nitrification. Such tests, however, do not simulate field conditions much more closely than would experiments on the habits of squirrels parallel nature if conducted in aquaria. Our results of comparative tests of the functions of bacteria in soils and in solutions have given us entire lack of faith in such abnormally conditioned experiments.

Again, plants have been grown in sterile soils under aseptic conditions, with constant and rigid chemical and bacteriological control. Such results may properly pose as qualitative. But they are not quantitative, because of necessity they are conducted on but a few plants and the factor of individual variation is so great that quantitative results are vitiated unless a sufficiently large number of plants be used to reduce the coefficient of error to something like a negligible quantity. Also the conditions of control involving abnormal radiation, ventilation, etc., are unsatisfactory.

Jost says:⁵

Many hundred culture experiments in water and sand have established the fact that nitric acid forms an excellent, not to say the best possible source of nitrogen for the great majority of plants. (How the divergent results arrived at by Treboux (1905) are to be explained it is, as yet, impossible to say.)

The recent comprehensive researches of Pitsch (1887-1896) and of Mazé (1900) have conclusively proved that the nutritive value of ammonia must not be entirely denied; in the majority of green plants it is second only to nitric acid in value.

⁵Jost's "Plant Physiology," pp. 134 and 135.

In the case of some plants, particularly maize and other Gramineæ, ammonia is by no means of inferior value to nitric acid, for Mazé was able to obtain as great an increase in dry weight in maize, using at most a one half per cent. solution of ammonium sulphate, as when he supplied it with a solution of a nitrate. Similar results were obtained in cultures of *Brassica* and species of *Allium*. Forest trees also must be dependent on ammonia, since nitrates are seldom present in woodland soils.

So far as we know at present it is quite certain that in addition to plants which definitely prefer nitric acid (*e. g.*, buckwheat, potatoes, turnips) there are others which get on just as well or even better with ammonia.

Perhaps after all the most conclusive proof that plants in nature can do well without nitrates comes from the fact that certain peat soils have been shown to be devoid of nitrates, yet they amply support plant growth. Again, rice responds well to ammonia even in soils where no nitrification can be detected.

Also it is true that we, as well as other investigators, have shown that soils very low in nitrification may be very productive and that on such soils plants respond readily to organic matter or ammonia, indicating that nitrification is often not an essential factor to soil fertility.

The general conclusion regarding the availability of ammonia and nitrate-nitrogen is that both can be used by many plants; that often nitrate nitrogen applied in the field gives larger crop yields. But the relative availability of these nitrogenous substances for crop plants under natural conditions has not yet been determined. This is an essential desideratum. A question that must be answered conclusively before we can know the significance of nitrification and denitrification.

It seems after all that ammonification is the essential thing and that nitrification is relatively unimportant, but this is only indicated, not proved.

There is need of rigid proof as to the relative availability to each crop plant of ammonia and of nitrate nitrogen. Then we shall know the true importance of the problems of nitrification and of denitrification. Following

this knowledge will come the questions of correcting such evils as need correction, the heightening of nitrifying power in cases where this is low and where higher nitrification would be of advantage; the lowering of denitrification if this be a disadvantage and where it is a disadvantage.

Plant physiology must join hands with soil bacteriology to ascertain which are the significant problems that conditions of deficiency may receive correction.

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REACTIONS OF YOUNG LOBSTERS DETERMINED BY FOOD STIMULI

IN recently glancing through some old notes written several years ago, when the writer was interested in problems relating to the behavior of the larval lobster (*Homarus americanus*), certain unpublished data regarding the reactions to food-stimuli came to light. It is the aim of the present note to give some of these data, which may be regarded as supplementary to the material published in 1908,¹ terminating the writer's investigations on the subject of behavior of *Homarus*.

Many students of animal behavior have learned that the condition of hunger is able to greatly modify the reactions of organisms to many stimuli—especially to food. Generally speaking, it has been found that hunger prevents the manifestation of certain normal types of reaction. The effect of hunger upon certain stages of *Homarus* is no exception to this rule. In this instance, however, the condition of hunger has been thus far found instrumental in modifying the reactions of the lobster only in the fourth and later stages, for similar experiments upon lobsters in the earlier stages have not yet been made. One reason for this is the fact that the larval lobsters of the first three stages are not able to direct their own activity in a definite direc-

¹ "The Behavior of the Larval and Early Adolescent Stages of the American Lobster (*Homarus americanus*)," *Journ. Comp. Neurol. and Psychol.*, 1908, 18, (3), 199-301.

tion, as toward food; and it is not until the fourth stage is reached that the lobster can be truly said to be master of its own movement. It was learned in the early stage of the investigations on the behavior of the fourth-stage lobsters that, if any study at all was to be made of their reactions to light, the lobsters must first be fed—and well fed. For, if such was not the case, the tendency to eat one another usually annihilated any possible manifestation of a response to the influence of light or other stimuli. Even if the condition of hunger did not excite these extreme cannibalistic instincts, and so preclude all experimentation, it produced a manifestation of unrest which made any results in the way of numerical counts impossible. As has been shown in earlier papers, the fourth stage-period, at least in the early part, is typically a “swimming-period”—the “swimming-period” *par excellence* of the lobster's whole existence. It is not until the latter part of the fourth stage-period that the lobster, under the proper conditions of environment, goes to the bottom and begins to burrow in the sand or under the bits of shell. Now it was found that the condition of hunger appeared to have a very definite influence upon the time at which this burrowing “instinct” was first “liberated” in the fourth-stage lobster. To determine this point, several experiments were performed of which the following is a fair example of all.

Experiment A

Influence of Hunger on “Burrowing.”—On August 5 about thirty early four-stage lobsters were taken from one of the confinement bags, in which they were being reared. They did not show much evidence of hunger and were therefore isolated for 48 hours without food. At the expiration of this time, all proved to be very hungry. Now two groups of five lobsters each were taken from this lot, and each group was placed in a 14 cm. crystallization dish, the bottom of which was covered with sand, gravel and shells. Immediately after this, one group of lobsters was fed with chopped clam meat; the other group was

left hungry. The dishes were then placed on the laboratory table, and records were taken frequently to ascertain at what time the burrowing would be first manifested; and in which group of lobsters—the fed or the unfed. For some little time the members of both groups swam more or less constantly at or near the surface. Further records, which show the time of burrowing of the individuals in the two groups, may be presented as follows:

Time	Group Fed	Group Unfed
Aug. 7, 10:00 A.M.	1 larva burrowed.	5 larvæ swimming or crawling.
Aug. 7, 11:30 A.M.	2 larvæ burrowed.	5 larvæ swimming or crawling.
Aug. 7, 3:30 P.M.	3 larvæ burrowed.	5 larvæ swimming or crawling.
Aug. 8, 9:00 A.M.	4 larvæ burrowed.	5 larvæ swimming or crawling.
Aug. 9, 9:00 A.M.	4 larvæ burrowed.	3 larvæ burrowed. ²
Aug. 9, 6:00 P.M.	4 larvæ burrowed.	4 larvæ burrowed.

These results appear to show that hunger may postpone the liberation of the burrowing instinct, while satiety appears to favor its early appearance. One other experiment, and the converse of the previous case, may be introduced.

Experiment B

Influence of Food-stimulus upon Surface-swimming in the Fourth-stage Lobsters.—In this case about twenty mid and late fourth-stage lobsters were placed in a glass jar 25 cm. in diameter filled with salt water to a depth of 10 cm. These lobsters were kept without food until they showed evident signs of hunger. All the lobsters remained on the clean bottom of the jar, over which they crawled or lightly swam. Occasionally one would come to the surface, only to leave it again for the bottom of the jar. Now a long pipette was partly filled with fresh clam juice, and the outside of the pipette carefully washed to take away all possible trace of clam odor

² At this point in the experiment one of the five lobsters was killed and eaten by the others, three of which immediately burrowed.

from the surface of the tube. When the lobsters were found to be resting quietly on the bottom of the dish, the point of the pipette was slowly lowered to the very bottom of the jar, where a few drops of clam juice were liberated in the vicinity of the fourth-stage lobsters. Within a few seconds all the lobsters in that region rose immediately to the surface of the water and swam wildly about for a variable length of time, after which they again went to the bottom of the jar. Here they either rested permanently or, if a sufficient amount of the clam juice remained near the bottom of the jar, apparently restimulated, the lobsters manifested further surface-swimming. These same tests were tried on the fifth-stage lobsters, but, although the clam juice might excite them to more active crawling over the bottom of the jar, it never produced surface-swimming, as in the case of the fourth-stage lobsters. These observations have received further support from the facts which the writer once learned from Dr. V. E. Emmel. It appeared in his case that the hungry lobsters with which he chanced to be working, when stimulated by a piece of clam meat dropped into their confinement bottles, would not remain on the bottom to enjoy the morsel, but would rise to the surface and manifest active swimming for some moments. These few observations demonstrate clearly that the lobsters, at least of a certain age, respond very definitely to certain kinds of food-stimuli. To what extent this kind of reaction may be responsible for the surface-swimming so characteristic of the early fourth-stage lobsters under natural conditions it is difficult to say. It is not improbable, however, that, after the fast which usually accompanies the approach of the third moulting-period the great hunger which characterizes the early fourth-stage lobster may be, in part, at least, the cause of the surface-swimming, although, as has been shown in previous publications, the reaction to light is also no doubt an influential factor.

PHILIP B. HADLEY

KINGSTON, R. I.,
January 22, 1912

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 458th regular meeting of the society was held in the new National Museum at 4:45 P.M. on February 6. Professor Mitchell Carrell presented a paper entitled "The Excavations at Knossos or Labyrinth of Minos," illustrating his talk with the lantern.

On February 20 the retiring president, Dr. J. W. Fewkes, made an address on "Great Stone Monuments in History and Geography," at eight o'clock in the new National Museum. Dr. Fewkes's paper will appear in full in the Smithsonian Miscellaneous Collections.

THE 459th regular meeting of the society was held in the new National Museum at 4:45 P.M. on March 12. Miss Densmore read a paper on the "Sun Dance of the Teton Sioux." This paper was based upon a study of the sun dance made among the Teton Sioux on the Standing Rock reservation in North Dakota and represents the sun dance usage in that band of the tribe. The study was conducted in a series of councils to which the old leaders of the tribe came from a radius of about a hundred miles. Fifteen reliable men were selected to give the account of the sun dance, their authority being established by interviews with about forty members of the tribe, in widely separated localities. Those who took part in the sun dance councils were men who bore upon their bodies the scars of their participation in the sun-dance tortures, and among them were the man who acted as intercessor in the ceremony and the man who "did" the cutting of those who fulfilled vows, both men being the only Tetons living who had performed these official acts. The men comprising the sun-dance council, with the writer and an interpreter, visited the site of the last sun dance held by the Teton Sioux in 1882, the site being identified by the Indians. The place where the sun-dance pole was erected, the outline of the "shade-house" and the location of the "sacred place" were recognized and measurement showed them to be correct, according to the usual plot of the sun-dance grounds.

The sun dance was held annually by the Sioux and was distinctly a religious ceremony. The fulfilling of vows of torture was an important part of the ceremony, the vows having been made by men in danger on the warpath. When making the vow they asked

for a safe return and that they might find the members of their family alive and well, and the fulfillment of the vow was required whether the prayer was granted or denied.

The paper was illustrated by songs of the sun dance which had been recorded by the phonograph and were played on the piano. Many of these were ceremonial songs and known only to the man who sang them for the speaker. One of these men has died since the songs were recorded. A collection of old ceremonial articles used in the sun dance was also exhibited.

THE 460th regular meeting of the society was held April 10 at 4:45 P.M. in the new National Museum. The speaker of the afternoon was Professor Pittier, who delivered an address on "Notes on the Native Tribes of Panama," with all of whom he came in contact in the course of his travels.

There is much confusion current as to the number of the so-called tribes and the stocks to which they are related. The numerous names recorded correspond in fact not to distinct tribes, but merely to villages, names of chieftains, or, in a general way, to what the old Spanish chroniclers used to design as "parcialidades."

In the present time there are east of the Canal Zone only two distinct "nations," viz., the Cunas, or Cuna-Cuna, to which the San Blas Indians belong, and the Chocoos to the south, beyond the Tuyra River. The line that separates these two stocks is at the same time the ethnological boundary between South and Central America.

The Cunas are a very numerous and strong race, almost uniformly of short stature and broad shoulders. They are very jealous of their independence and shun all interference on the part of strangers, including the Panamanian government, the authority of which over them is only nominal. The Cunas of the northern coast, east of Nombre de Dios, or San Blas Indians, are far above the other Panamanian aborigines in their social and economic development; they constitute one of the best elements of the population included in the territory of the young republic, being thrifty and enterprising and having made of their extensive coconut palm plantations a real source of wealth. The remaining Cunas, known as Bayanos, Chucunacas and Payas, live in the interior and are less advanced, the two former groups being acknowledged as real "Indios bravos." All speak one language, with slight local variations.

The Panamanian Chocoos are but the northernmost branch of a numerous stock which extends more or less continuously along the Pacific coast of South America, from Punta Grachine in Darien, to the Ecuadorian boundary. In the Sambú Valley, where Professor Pittier found them, they are a happy lot, usually tall and well built, scantily clothed and living quite near to nature.

West of the Canal Zone, in the mountains of Veraguas and eastern Chiriqui, live the polygamous Guaymies, once under the care of the Spanish missionaries, but who have long since gone back to their own independent life and customs. They do not, however, avoid or repel the contact with the other natives, and owing to the rapid expansion of the neighboring populations, so-called civilized, the Guaymies are doomed to soon lose their characteristics and individuality as a race. Certain ethnological traits, as well as their physical appearance, point to a relationship with Costa Rican tribes.

In consequence of what Professor Pittier calls a "caprice of arbitration," the Republic of Panama has acquired the northern branch of the Terrabas or Tirúb of Costa Rica. These dwell in small and rapidly dwindling numbers at the headwaters of the Teraria or Tilorio, the main branch of the Changuinola River. They have been investigated by Pittier in the course of his survey of Costa Rica.

These four are the tribes represented to-day in Panama. The Dorasques, supposed by some to descend from the great Chiriqui pottery makers, seem to have disappeared, unless the Brunka of Costa Rica are really what is left of them.

With reference to the possible affinities of the Panamanian tribes with the neighboring stocks, the speaker took absolute exception to the theory of the Chibchan relationship, which he was one of the first to advocate about twenty years ago and which has since received general acceptance under the authority of Brinton, Deniker and others. The pretended relationship is founded merely on linguistic analogies and on the apparently common origin of quite a number of words. But these facts can be taken as conclusive only if supported by anthropological common characteristics and also by partial community of uses and customs. Physically, the Cunas are strikingly distinct from the Guaymies and the Costa Rican Indians, and both stocks offer none but general racial likeness with what is left of the original Chibchas.

In the opinion of Professor Pittier the origin of the Cuna-Cuna has to be looked for elsewhere than in the interior of Colombia, and the Guaymies, Valientes, Bribri, Térrabas, Sumos, etc., are more likely to be the remnants of a primitive autochthonous stock. Pittier's talk was illustrated by numerous lantern slides and the exhibition of the objects collected among the Chochoes and Guaymies.

TRUMAN MICHELSON,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE 81st regular meeting was held at the Cosmos Club, May 7, 1912, at 8:00 P.M. President W. A. Orton presided. Twenty members were present.

The following papers were read:

Further Studies on the Pecan "Rust": F. V. RAND.

A preliminary report on the fungus causing this pecan leaf disease was published in *Phytopathology* for August, 1911, under the name *Mycosphaerella convexula*. Since that time the fungus in question has been obtained from a number of other sources and several strains known to have originated from single two-celled ascospores have been under study. In the course of one and one half year's growth in culture, strains originally producing a majority of apparently two-celled ascospores have gradually changed, until now most of the ascospores are distinctly non-septate. Furthermore, a typical *Glæosporium* form was developed in culture and also obtained from the host. A large number of colonies known to have originated from single ascospores or single conidia all gave cultures producing both perithecial and conidial forms, showing the two to be different phases in the life cycle of the same fungus. Inoculations on Jonathan and Yellow Newton apples gave a decay similar to bitter-rot, with production of conidia and immature perithecia on the latter. Inoculations on young pecan leaves under greenhouse conditions gave negative results, but infections together with production of conidia and mature perithecia, readily occurred on living leaves in a damp chamber. From the studies summarized above it would appear that the fungus is closely related to if not identical with *Glomerella rufomaculans*, and that it is not a very active parasite on the pecan.

Distribution of Pigment in the Seed-coat of the Cowpea: Dr. ALBERT MANN.

Transverse sections of the seed-coat disclose three principal layers of cells: an outer palisade

layer, a heavy-walled layer below this of empty cells, and a layer of considerably compressed cells with long axis parallel to the surface of the cowpea.

It was found that the colorations in the cowpea are the result of pigments deposited in two of these layers. In all colored cowpeas there is a basal color or practically uniform tint and invariably to be found in the lowest of the three layers, which the speaker terms the basal color layer. This is a melanin compound of an orange-yellow tint, grading into lemon-yellow and pale buff. All other colors are obtained by superposing upon this basal color layer various pigments, and these are uniformly deposited in the palisade cells, and as a rule in the lower and larger third of the cell cavity. Three colors are found here: black to blue-black, or sometimes purple tint, which is an anthocyanin, a yellow or brassy-brown pigment and an intense black pigment, the last two being melanin compounds. By various arrangements of these three superposed tints in the palisade cells, or by the absence of any pigments in these cells, the various schemes of coloration in the cowpea are obtained; the marbling, blotching, dotting, as well as the uniform colors of some cowpeas, being produced by the basal color plus such superposed arrangements of color in the palisade cells as are characteristic of the different varieties.

In the case of the few cowpeas having white or colorless seed-coats, the result is obtained by the suppression of all pigments both in the basal color layer and in the palisade layer.

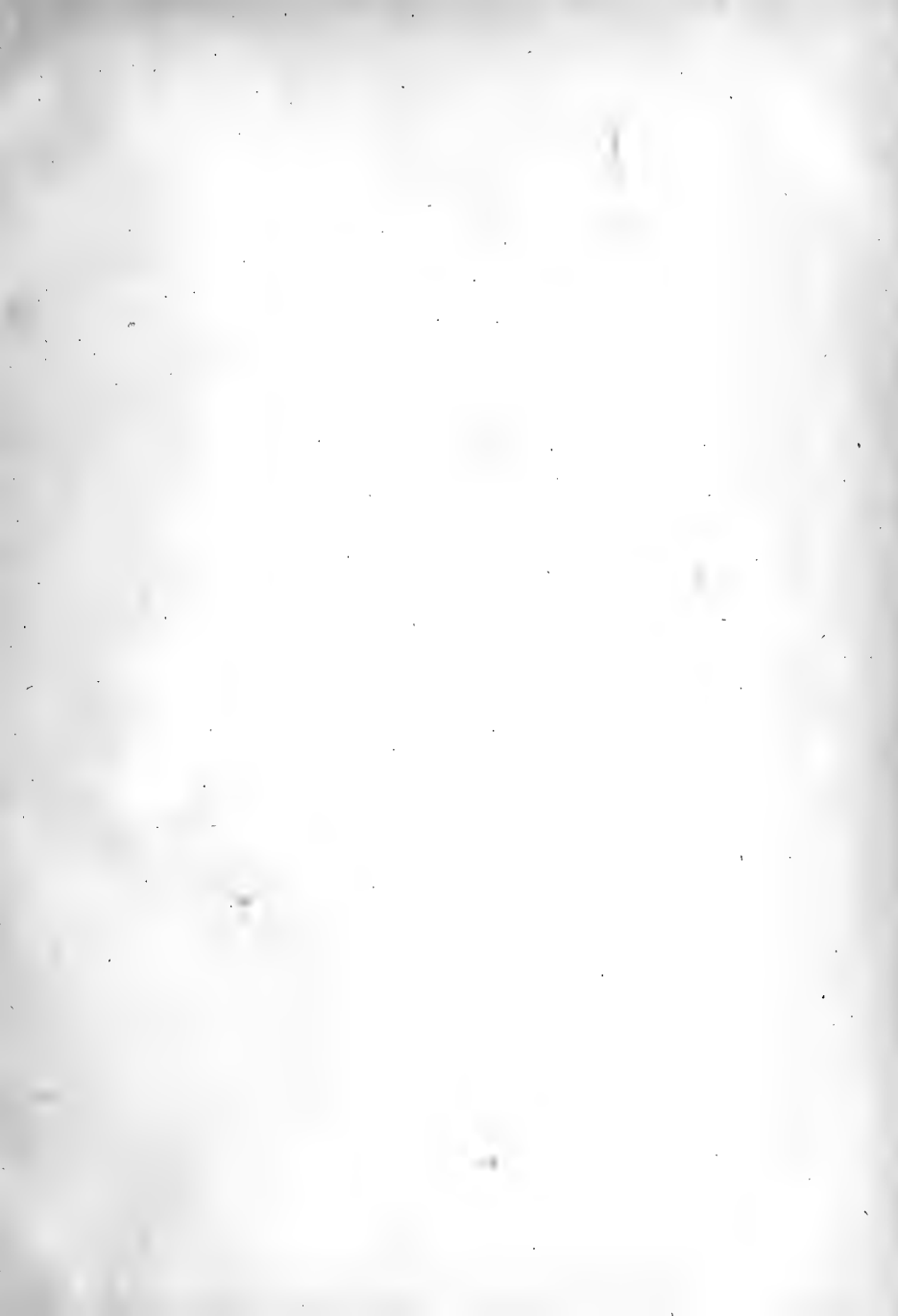
A wild cowpea secured from North Nigeria, Africa, is of particular interest, in that upon the same cowpea all the elements of color, as well as all the schemes of coloration are to be found.

The Purpling Chromogen of the Hawaiian Bitter Yam: H. H. BARTLETT.

Illustrations of the Phytogeography of the North American Continent: Dr. JOHN W. HARSHBERGER (by invitation).

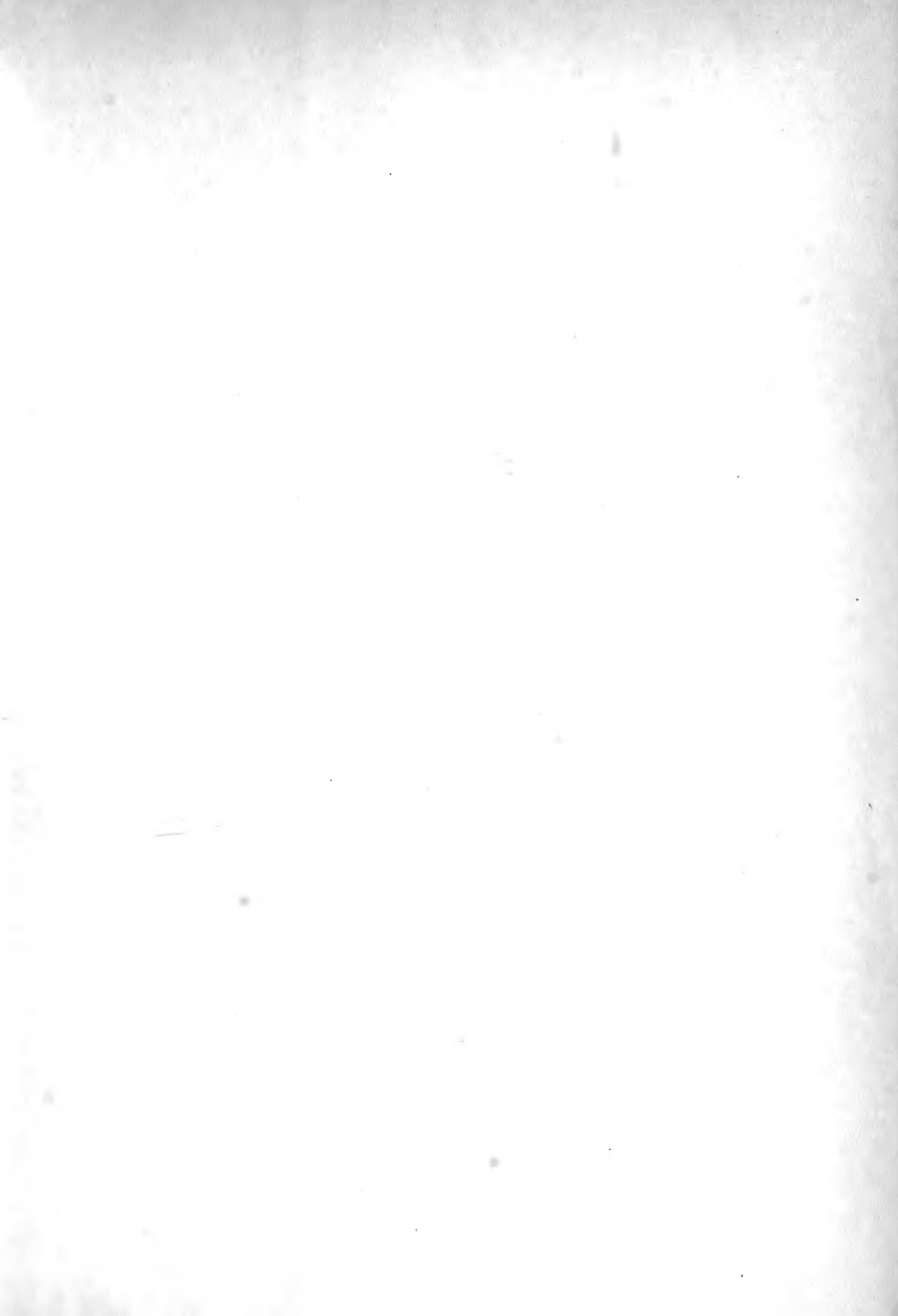
The speaker displayed to the society an album of twelve volumes of photographs and illustrations of North American vegetation, collected during the preparation of his recently published work on the phytogeography of North America. The source of the material and method of preparation and classification were discussed, and the general plan and scope of the work were explained in detail.

W. W. STOCKBERGER,
Corresponding Secretary













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